

Figure 4-27. ARA-III in situ gamma survey and estimated Cs-137 concentrations in the top 1 in. of soil.

receive waste until 1973. From 1981 to 1984, raw coolant water was the only effluent. In 1984, discharge pipes to the well were sealed with concrete, and the well was capped and sealed with concrete. The location of the well is shown in Figure 4-28.

4.2.3.1.2 Site Investigations—Sampling has not been performed at the site. However, discharges were limited in activity to 18,800 cps above background. An approximate total of 0.48 Ci was released to the well over its operational lifetime. Radionuclides with total discharges higher than 0.01 Ci and half lives longer than 10 years are Cs-137 (0.30 Ci) and tritium (0.02 Ci) (Hillman-Mason et al. 1994). Strontium-90 also was identified as a COPC (see Rohe, Sondrup, and Whitaker 1996 in Appendix J).

4.2.3.1.3 Nature and Extent of Contamination—Because sampling has not been performed at the site, the nature and extent of contamination has not been empirically determined. However, potential contamination associated with the injection well is assumed to be limited to the subsurface, and was evaluated using the GWSCREEN computer model (see Rohe, Sondrup, and Whitaker 1996 in Appendix J). The simulated source term was estimated by using data from discharge records. The fate and transport modeling for this site is summarized in Section 5, and the PBF-05 evaluation is presented in detail in Rohe, Sondrup, and Whitaker (1996) in Appendix J. The simulated source is illustrated in Figure 4-29. Contaminants from the PBF-05 vadose zone injection well have not be detected in aquifer monitoring wells (see Section 4.3).

4.2.3.2 PBF-10—PBF Reactor Area Evaporation Pond (PBF-733).

4.2.3.2.1 Site Description—The PBF-10 site was a lined surface impoundment with an approximate area of 1,820 m² as shown in Figure 4-30. Effluent routed to the pond from 1972 to 1984 included chromium-contaminated water from the PBF reactor secondary coolant loop and discharges containing resins, sulfuric acid, and sodium hydroxide from the demineralizer system. After 1984, discharges to the pond did not contain chromium. A 1994 interim action (Parsons 1995) included excavation of sediments from the pond in areas with concentrations of chromium greater than 800 mg/kg or concentrations of Cs-137 greater than 30 pCi/g, and post-removal verification sampling from sediments above and below the liner to verify the adequacy of the interim action. Soils contaminated above the action level were containerized and transported to the RWMC. In 1995, the liner was removed and disposed of in the Central Facilities Area Bulky Waste Landfill. The berm was pushed into the pond, and the area was graded and seeded with native grasses.

4.2.3.2.2 Site Investigations—Pond sediments were sampled in 1987. In 1989, 22 sediment samples were analyzed for gamma-emitting radionuclides. In August 1994, the pond was divided into 49 grids of 20-ft squares. Twenty-one of the grids were identified as contaminated, and the sediment was excavated. Following excavation of the contaminated grids within the evaporation pond, samples of the remaining sediments were collected from four locations above the pond liner and four locations below the pond liner. Cesium-137 and chromium concentrations were detected (Parsons 1995).

4.2.3.2.3 Nature and Extent of Contamination—A plot of the profile of soil contamination at the PBF-10 site is provided in Figure 4-31. Contaminant concentrations from the 1994 sampling in locations that were not excavated were used. The upper layer of soil at the PBF-10 location came from the berm that originally surrounded the pond, and that soil is assumed to be uncontaminated. Cesium-137 was the only contaminant retained for quantitative evaluation based on the detection above background values in sediments above the pond liner. Cesium-137 detections were within normal background ranges in soil samples collected in 1994 from below the pond liner (Parsons 1995); therefore, contamination is assumed to be zero below the depth of the pond liner.

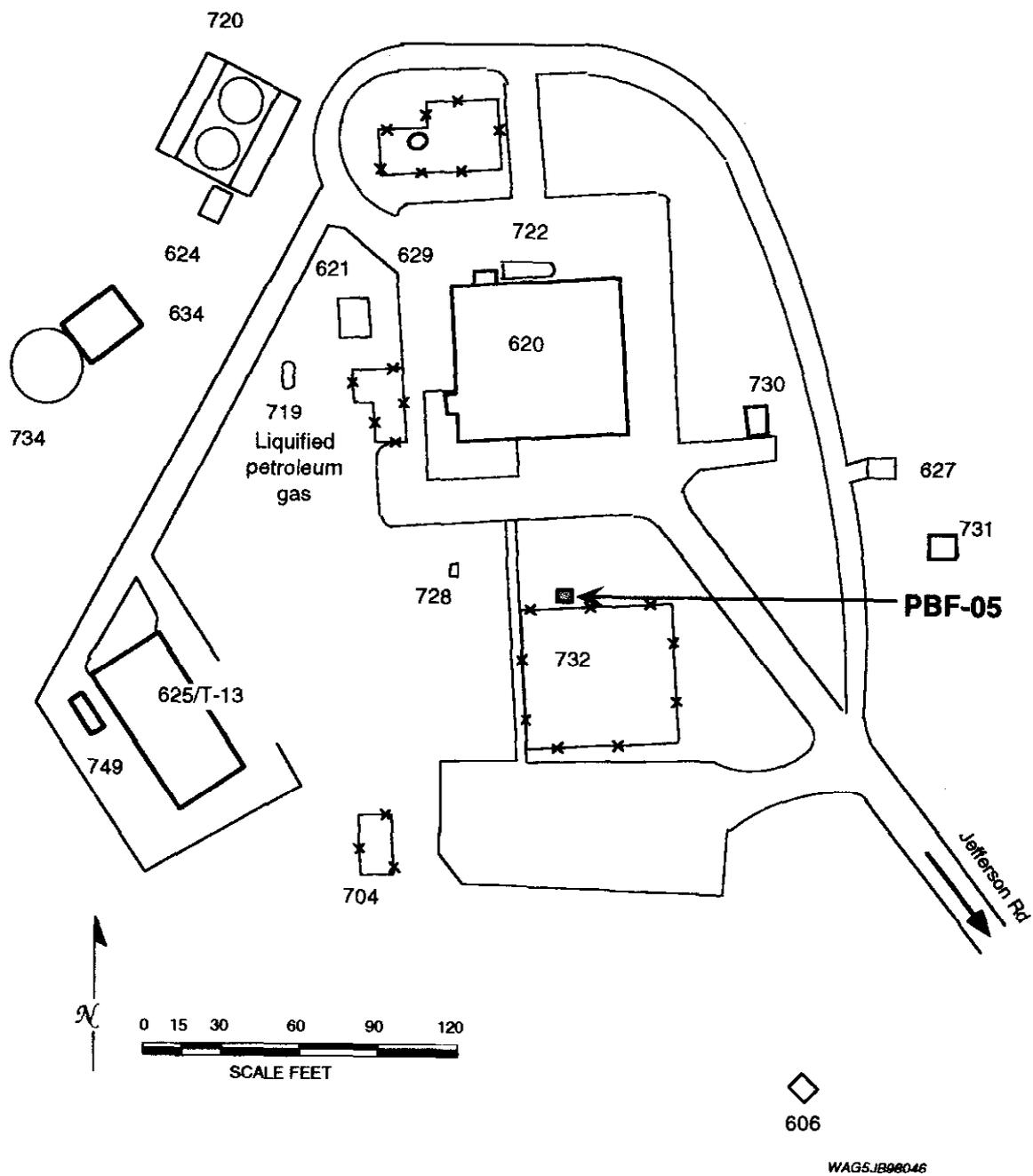
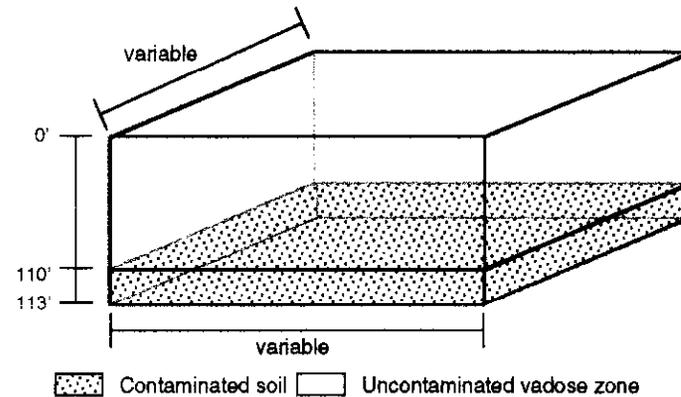


Figure 4-28. PBF Reactor Area warm waste injection well, Site PBF-05.

Liquid Discharge Rates to Injection Well PBF-05					
INWMIS Database*			RWMIS Database*		
Year	Volume (m ³)	Average (m ³ /yr)	Year	Volume (m ³)	Average (m ³ /yr)
1973	3.187E+03	3,187	1973	8.147E+02	815
1974	2.055E+03	2,621	1974	1.657E+03	1,236
1975	5.290E+03	3,511	1975	1.578E+03	1,350
1976	1.430E+04	6,208	1976	1.710E+03	1,440
1977	8.379E+03	6,642	1977	2.143E+03	1,581
1978	6.860E+03	6,679	1978	6.567E+02	1,427
1979	7.783E+03	6,836	1979	4.598E+02	1,288
			1980	5.163E+01	1,134
Total	4.785E+04	6,836	Total	9.071E+03	1,134

* INWMIS - INEEL Non-radiological Waste Management Information System (DOE-ID, 1996a)
RWMIS - Radiological Waste Management Information System (DOE-ID 1996b)



Contaminant Discharge Rates to Injection Well PBF-05					
Contaminant	Total Activity Discharged (Ci)	Years Disposed	Total Years	Rate of Input (Ci/yr)	Reference
Cs-137	3.020E-01	1975-80	6	0.5033	(DOE-ID, 1996b)
Sr-90	1.804E-03	1975-80	6	0.0030	(DOE-ID, 1996b)
Co-60	2.749E-03	1975-78	4	0.00069	(DOE-ID, 1996b)
H-3	2.100E-02	1974-80	7	0.00300	(DOE-ID, 1996b)

Assumptions:

- The PBF-05 injection well was modeled as both a standing water pond and buried source using the GWSCREEN model code. The discharge rates to the well during the operating period were modeled as infiltration through the pond sediments. Contaminant transport was modeled for the post-operational period as the infiltration of natural precipitation through the simulated source zone, which was developed during the operational period. A source-zone vertical thickness of 1 m was assumed.
- The pond area was estimated based on representative saturated hydraulic conductivity of sedimentary interbeds and liquid effluent discharge rates using the equation:
$$\text{pond area} = \text{discharge rate} / \text{saturated hydraulic conductivity} = \text{m}^2 = (\text{m}^3/\text{yr}) / (\text{m}/\text{yr})$$
- Zero contaminant source concentrations were assumed for the start of simulations.

Notes:

- Site-specific soil concentrations are not available for PBF-05. Nature and extent of contamination estimates were limited to estimates of groundwater contamination resulting from discharge into PBF-05.

Figure 4-29. PBF-05 PBF Reactor Area warm waste injection well simulated source term and assumptions for risk assessment.

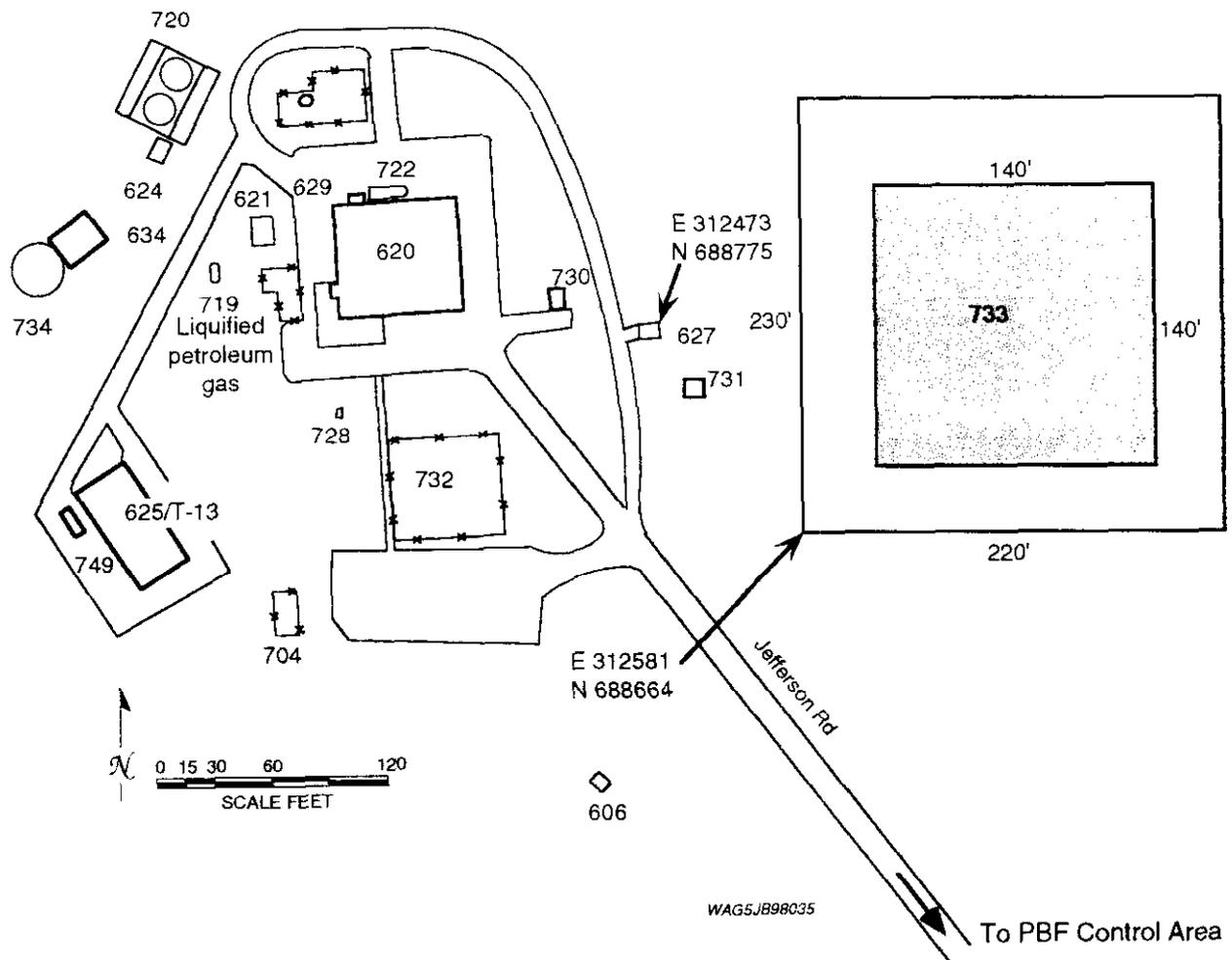
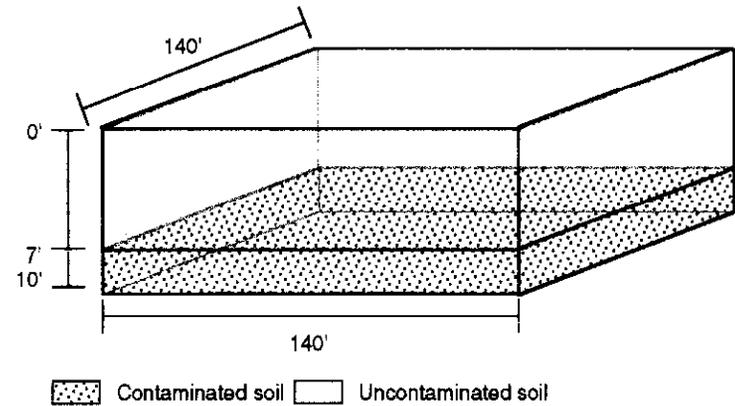
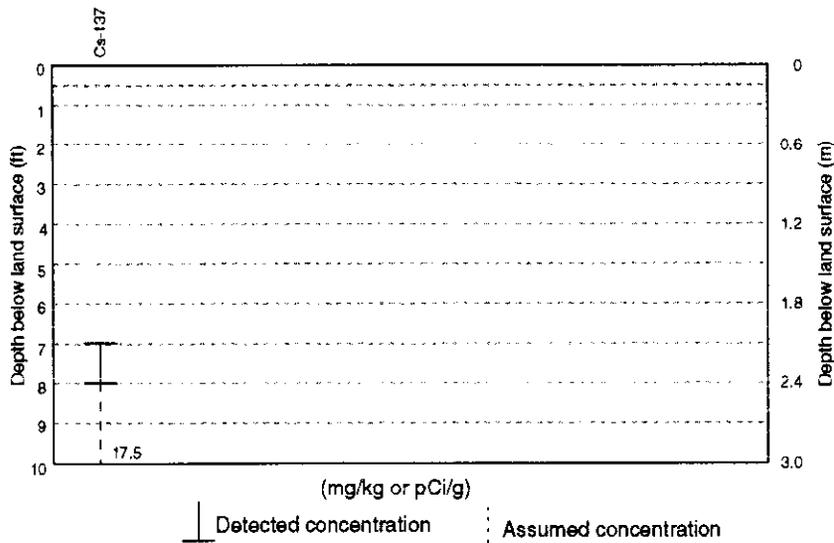


Figure 4-30. PBF Reactor Area evaporation pond, Site PBF-10.



Assumptions:

- The area of the site is the area of contamination: 140 ft × 140 ft = 19,600 ft².
- The top 8 ft of soil overlying the site, once comprising the berms around the pond, is uncontaminated.
- The vertical interval for the site is 10 ft, and the 8 ft is uncontaminated.
- Contamination is limited to the top 10 ft.
- The simulated source term volume is the area times the contaminated vertical interval: 19,600 ft² × 10 ft = 196,000 ft³.
- All detections at 8 ft were assigned to the 7 to 8-ft interval for the purposes of calculating volume weighted average concentrations.

Notes:

- Simulated source term concentrations are depth-weighted averages calculated as follows:

$$C_I = \frac{\sum_{i=1}^I C_i}{I}$$

where:

C_I = depth-weighted average concentration over the entire interval I
 C_i = 95% UCL or maximum detected concentration, whichever is less, for the i th 1-ft increment
 i = specific 1-ft increment (i.e., 0 to 1 ft, 1 to 2 ft, ..., $I-1$ to I ft)
 I = the number of 1-ft increments.

- For PBF-10, $I = 10$.

Source Term Concentrations	
<i>Radionuclides (pCi/g)</i>	
Depth (ft)	Cs-137
0-0.5	0.00E+00
0-4	0.00E+00
0-10	5.25E+00

Figure 4-31. PBF-10 PBF Reactor Area evaporation pond source term concentrations and assumptions for risk assessment.

4.2.3.3 PBF-12—PBF SPERT-I Leach Pond.

4.2.3.3.1 Site Description—The PBF-12 site is the historical location of a 15 ft × 45-ft surface impoundment called the SPERT-I leach pond. As shown in Figure 4-32, the pond was located about 2,500 ft northwest of PBF and about 30 ft east of the main road into PBF. The site is a mounded area distinguished from the surrounding desert only by a cement location marker with a brass plate indicating the presence of subsurface residual radioactive contamination 8 ft belowgrade.

The SPERT-I facility was deactivated in 1964, and D&D was implemented in 1984. The D&D operations included removing the top 2.5 ft of soils in the pond area, collecting soil samples, and backfilling the pond with radiologically clean soil. Approximately 8 ft of clean soils cover the area.

4.2.3.3.2 Site Investigations—After the 2.5 ft of soil was removed from the PBF-12 site, nine soil samples were collected from those areas most likely to exhibit residual contamination. Concentrations of Co-60, Cs-137, Pu-238, Sr-90, U-234, and U-238 were detected. Though the data were not validated according to contemporary requirements, samples were collected, handled, and analyzed in a manner consistent with standard 1984 D&D protocols (EG&G March 1993). Some of the concentrations were in excess of background values established more than 20 years later for the INEEL by Rood, Harris, and White (1996). In October 1991, a surface contamination survey was conducted over the remediated site. Surface readings were less than 5 mrem/hour (EG&G March 1993).

4.2.3.3.3 Nature and Extent of Contamination—Contaminants at a depth of 8 ft below the surface include Co-60, Cs-137, Pu-238, Sr-90, U-234, U-235, and U-238 (EG&G March 1993). The concentrations shown in Figure 4-33 are decayed to present values from 1984 post-D&D concentrations.

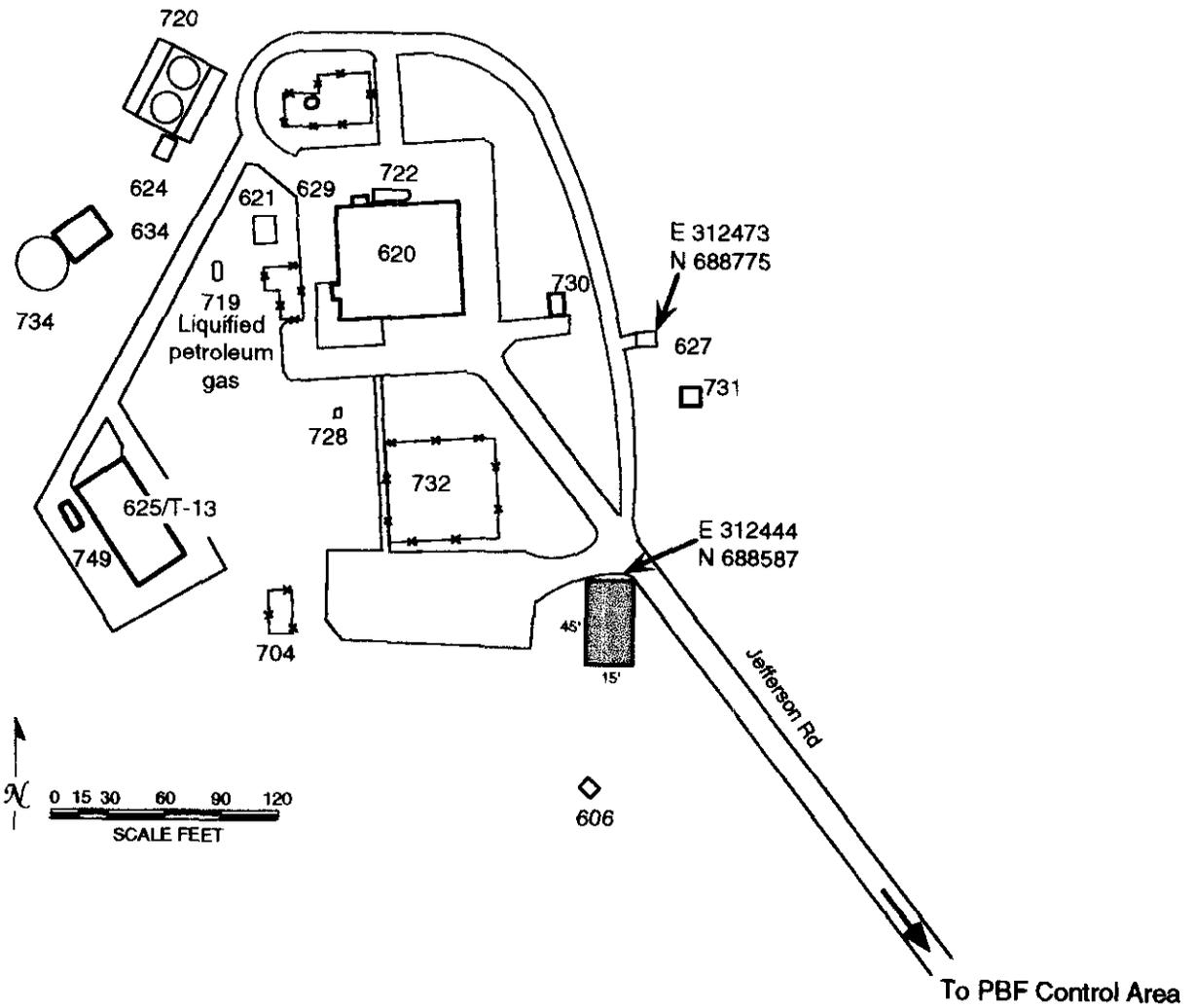
4.2.4 Group 4—Power Burst Facility Waste Engineering Development Facility

The WEDF facility, originally built to contain the SPERT-II reactor, was constructed in the late 1950s. The SPERT-II reactor was operational from 1960 to 1964. After the reactor was removed, the facility was converted to the WEDF. Current activities include waste treatment development and laboratory operations. A guardhouse is the only building besides the WEDF. An electrical substation, a leaching pond, a seepage pit, and a couple of underground tanks are the only other structures. One site in Group 4, PBF-16, was evaluated in the BRA.

4.2.4.1 PBF-16—PBF SPERT-II Leach Pond.

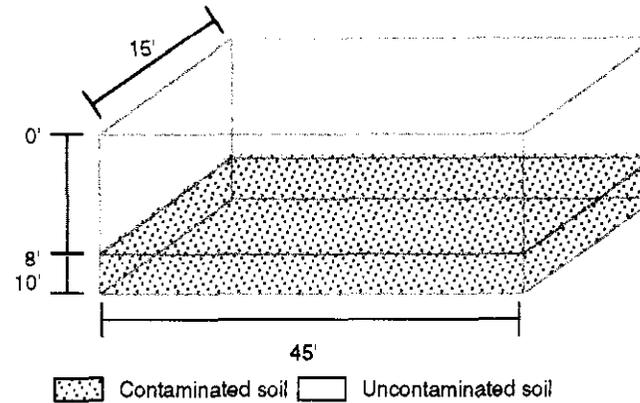
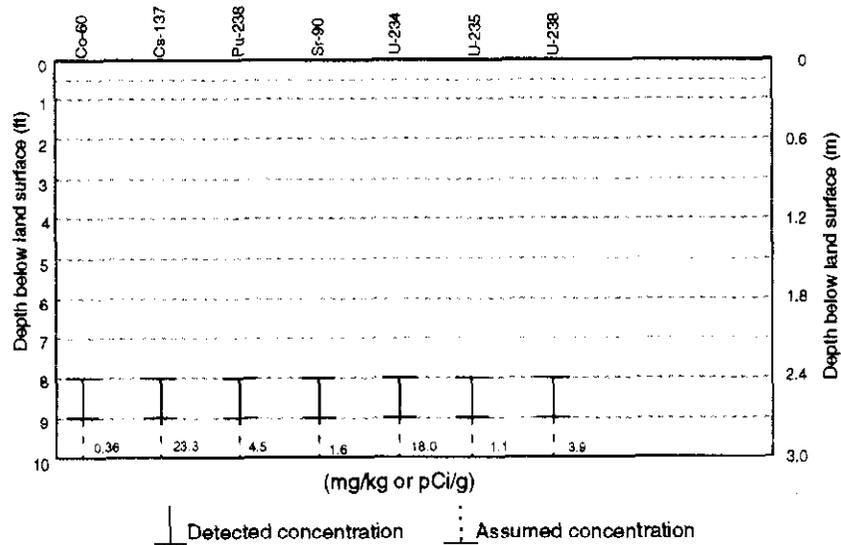
4.2.4.1.1 Site Description—The PBF-16 site is an asymmetrical 2,740-m², fenced, unlined surface impoundment located south of the WEDF as illustrated in Figure 4-34. The leach pond was used to dispose of spent sulfuric acid and sodium hydroxide solutions from regeneration of the SPERT-II reactor demineralizer resin bed. Water softener waste, emergency shower drain water, and discharges from the floor drains from the reactor building also were disposed of in the leach pond from 1959 to 1964 (Hillman-Mason et al. 1994).

4.2.4.1.2 Site Investigations and Results—The SPERT-II Leach Pond was characterized for radioactivity in 1982 (EG&G 1982). The investigation used a sampling grid of 3-m squares in low-lying areas and 7.5-m squares elsewhere. Each square was surveyed for radioactivity with a scintillator meter, and the resultant readings were compared to background values. In addition, trenches were dug in three squares and 23 surface soil samples, six mud samples, and two water samples were taken. Clippings from new growth of various plants and trees were collected, and several smears were taken. Water and soil sample radioactivity levels were within the range of background for alpha-, beta-, and gamma-emitting isotopes. No radioactivity was detected from vegetation samples.



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Figure 4-32. PBF SPERT-I leach pond, Site PBF-12.



Assumptions:

- The area of the site is the area of contamination: 45 ft × 15 ft = 675 ft².
- The vertical interval for the site is 10 ft.
- The top 8 ft of soil overlying the site is uncontaminated.
- The simulated source term volume is the area times the contaminated vertical interval: 675 ft² × 10 ft = 6,750 ft³.
- D&D samples collected in 1984 and decayed to 1997 are representative of radioactive contamination at the site and are of adequate quality for risk assessment.

Notes:

- Simulated source term concentrations are depth-weighted averages calculated as follows:

$$C_T = \frac{\sum_{i=k}^I C_i}{I}$$

where:

- C_i = depth-weighted average concentration over the entire interval I
- C_i = 95% UCL or maximum detected concentration, whichever is less, for the i th 1-ft increment
- i = specific 1-ft increment (i.e., 0 to 1 ft, 1 to 2 ft, ..., $I-1$ to I ft)
- I = the number of 1-ft increments.

- For PBF-12, $I = 10$.

Source Term Concentrations							
Radionuclides (pCi/g)							
Depth (ft)	Co-60	Cs-137	Pu-238	Sr-90	U-234	U-235	U-238
0-10	7.20E-02	4.66E+00	9.00E-01	3.20E-01	3.60E+00	2.20E-01	2.70E-01

Figure 4-33. PBF-12 SPERT-I leach pond source term concentrations and assumptions for risk assessment.

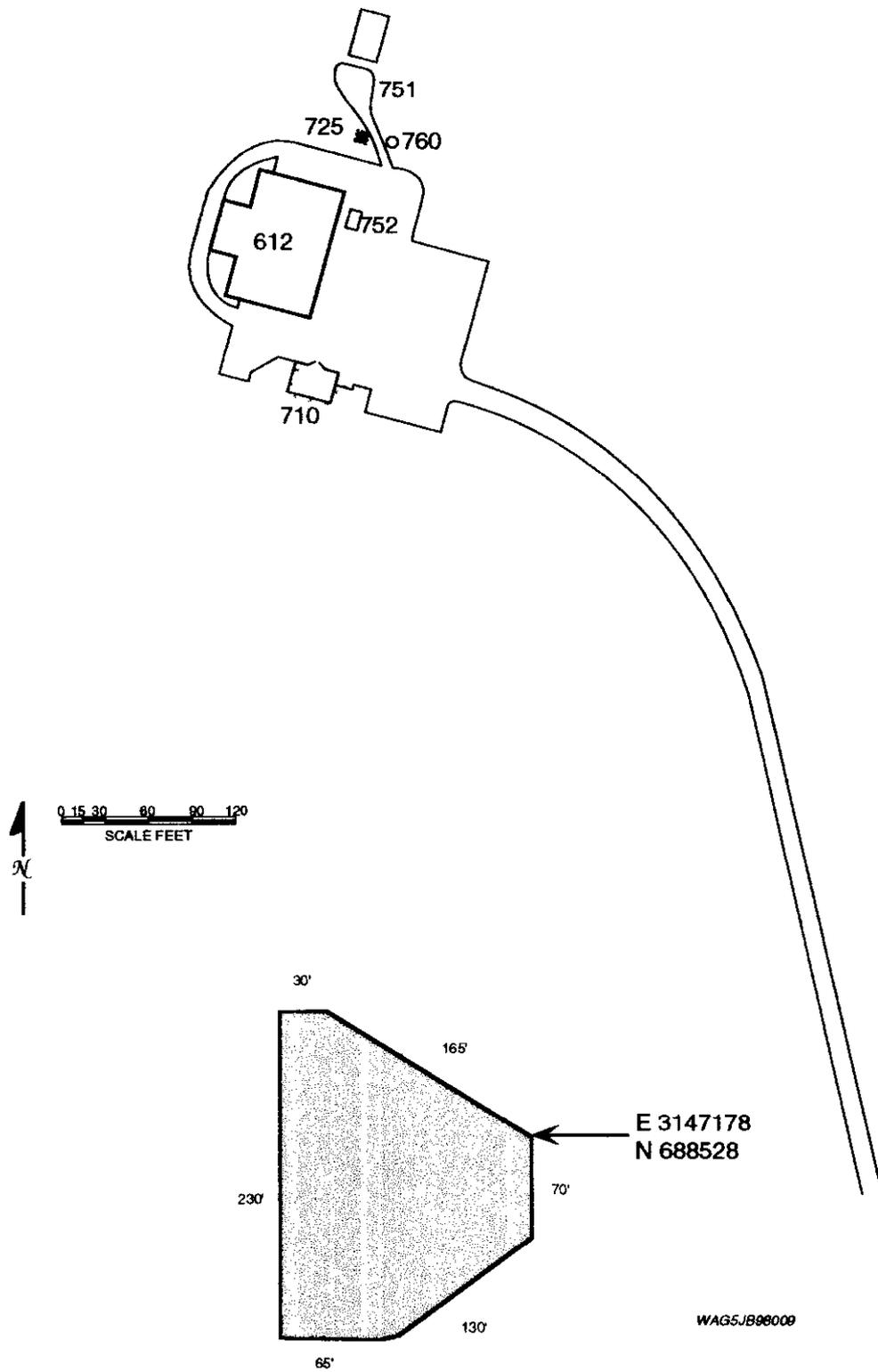


Figure 4-34. PBF SPERT-II leach pond, Site-16.

In 1983, another characterization was conducted to determine the presence and concentration of hazardous substances. Arsenic, cadmium, chromium, lead, and mercury were detected in pond sediments (Hillman-Mason et al. 1994), but all were below background concentrations except lead and mercury. Because the detected concentrations of mercury are significantly less than risk-based concentrations (see Table B-13), mercury was not evaluated.

4.2.4.1.3 Nature and Extent of Contamination—A plot showing the lead concentration (32 mg/kg) in the upper 1 ft of soil is provided in Figure 4-35. Lead is the only contaminant at PBF-16 that was retained for evaluation in the BRA.

4.2.5 Group 5—Power Burst Facility Waste Experimental Reduction Facility

The WERF building, originally constructed to contain the SPERT-III reactor, was constructed in the late 1950s. The SPERT-III reactor was operational from 1958 to 1968. The reactor building was subjected to D&D in 1980, and the building was modified to contain the WERF, which began operation in 1982. The operations involve the volume reduction of low-level radioactive waste. The area contains a metal processing facility and waste storage and handling building in addition to the WERF building, an electrical substation, two exhaust stacks, and underground tanks. The only site from Group 5 that was quantitatively evaluated in the BRA is PBF-21.

4.2.5.1 PBF-21—PBF SPERT-III Large Leach Pond.

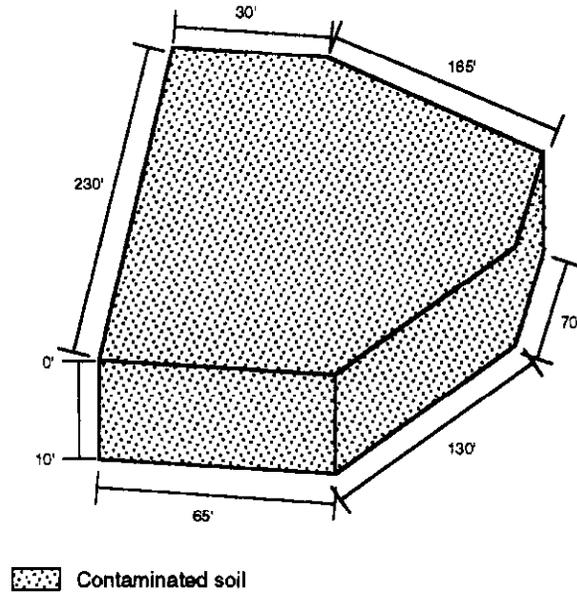
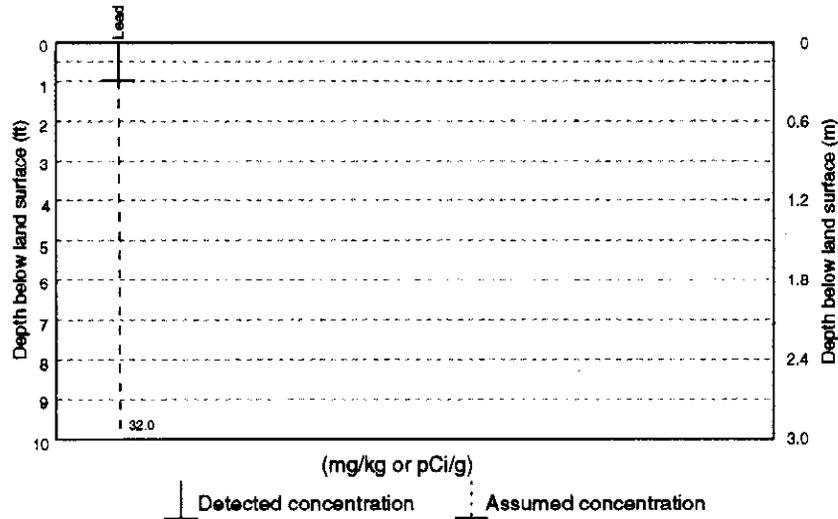
4.2.5.1.1 Site Description—The PBF-21 site is the historical location of a leach pond that received waste from the sump pump in the SPERT-III Reactor Building from 1958 to 1968. Primary coolant water was drained to the pond. The pond area, shown in Figure 4-36, is about 325 m². The pond was characterized in 1982 and was backfilled and reseeded by the D&D program in 1983.

4.2.5.1.2 Site Investigations—In 1982, 13 pond surface soil and 24 trench samples from the surface to a depth of 30 in. were analyzed. Concentrations of Co-60, Cs-137, Sr-90, U-234, U-238, Pu-239/240 were detected. In 1993, four soil samples were taken from below the clean fill soil at three locations at depths between 5.2 to 9 ft. No concentrations were detected above risk-based soil concentrations. Analyses were performed for all expected contaminants, and detections were all well below background concentrations (EG&G 1994). However, the sample locations did not correspond to probable areas of highest concentrations within the original pond.

4.2.5.1.3 Nature and Extent of Contamination—Three contaminants, chloride, orthophosphate, and sulfate, were detected in 1993 that had no corresponding risk-based concentrations or background values (EG&G 1994). Retained for analysis in the BRA, the contaminants were detected at depths between 5 to 8 ft as illustrated in Figure 4-37. The concentrations of radionuclides detected in the post-D&D samples from 1982 also were retained for evaluation. Because the area was backfilled during D&D of the site, the concentrations detected in 1982 were evaluated at depths greater than 6 ft.

4.2.6 Group 6—Power Burst Facility Mixed Waste Storage Facility

The MWSF originally housed the SPERT-IV reactor, which was operational from 1961 to 1970. After the reactor was removed, the building was modified slightly and converted to a waste storage facility. Mixed low-level waste, including radioactively contaminated PCB waste, is stored in the former reactor pit. The area also contains an electrical substation, a hot waste holdup tank, a leach pond, and underground tanks. Two sites from Group 6, PBF-22 and PBF-26, were quantitatively evaluated in the BRA.

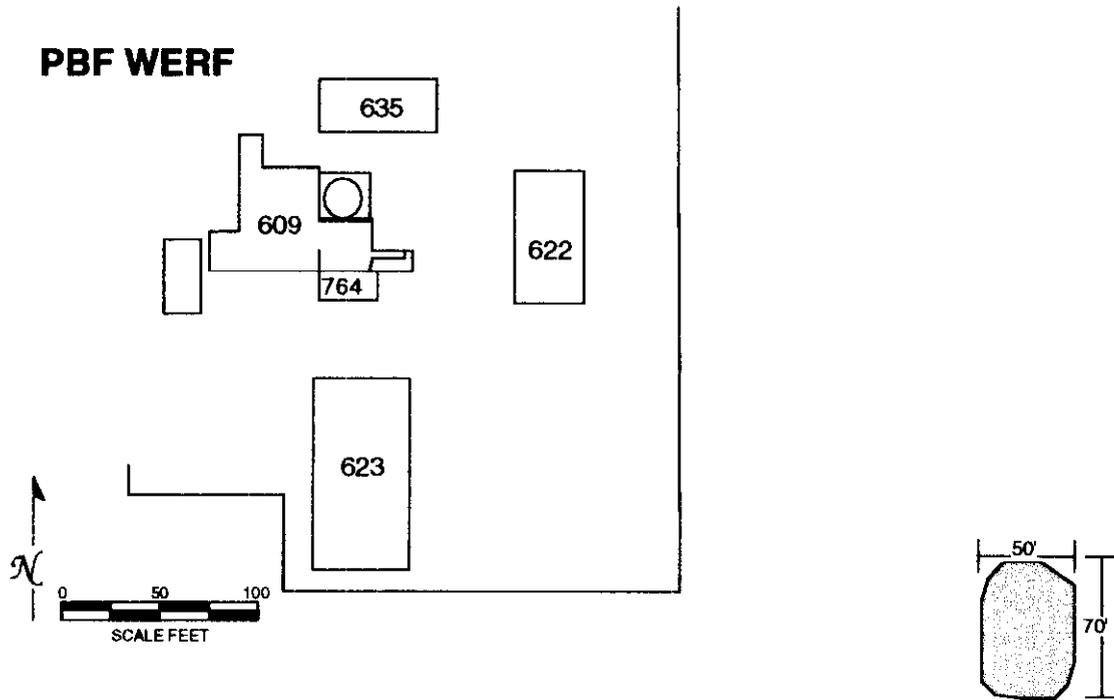


Source Term Concentrations	
Nonradionuclides (mg/kg)	
Depth (ft)	Lead
0-0.5	3.20E+01
0-4	3.20E+01
0-10	3.20E+01

Assumptions:

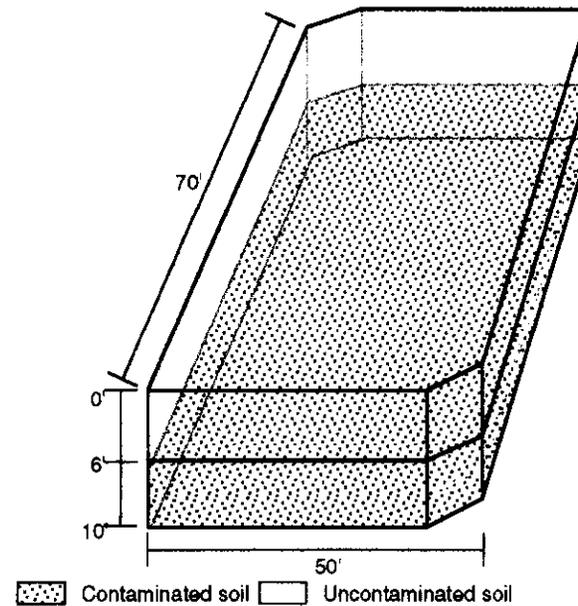
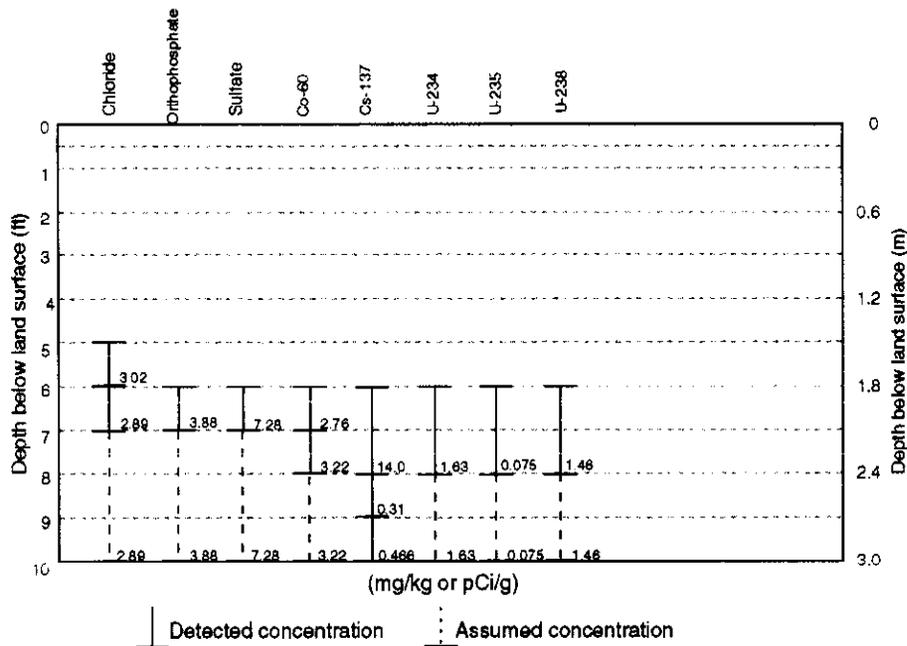
- The 29,500-ft² asymmetrical area of the site as shown above is the area of contamination.
- The vertical interval for the site is 10 ft.
- The simulated source term volume is the area times the vertical interval: 29,500 ft² × 10 ft = 295,000 ft³.
- The maximum concentration detected in the surface soils is representative of each interval within the entire source volume to a depth of 10 ft.

Figure 4-35. PBF-16 SPERT-II leach pond source term concentrations and assumptions for risk assessment.



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Figure 4-36. PBF WERF SPERT-III large leach pond, Site PBF-21.



4-50

Source Term Concentrations			
Nonradionuclides (mg/kg)			
Depth (ft)	Chloride	Orthophosphate	Sulfate
0-0.5	0.00E+00	0.00E+00	1.46E+00
0-4	0.00E+00	0.00E+00	1.55E+00
0-10	0.00E+00	0.00E+00	2.91E+00

Radionuclide (pCi/g)					
Depth (ft)	Co-60	Cs-137	U-234	U-235	U-238
0-0.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0-4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0-10	1.24E+00	2.87E+00	6.52E-01	3.00E-02	5.84E-01

Assumptions:

- The area of the site is the area of contamination: 70 ft × 50 ft = 3,500 ft².
- The top 7 ft of soil overlying the site is uncontaminated
- Contamination detected in the 7 to 8-ft interval is representative of concentrations in the underlying 2 ft of soil.
- The source term volume is the area times the vertical interval: 3,500 ft² × 10 ft = 35,000 ft³.
- D&D data collected in 1982 with concentrations reduced to reflect radioactive decay to 1997 are representative of radioactive contaminants at the site and are of adequate quality for risk assessment.
- Data collected in 1993 are representative of nonradioactive constituents at the site.

Notes:

- Source term concentrations are depth-weighted averages calculated as follows:

$$C_I = \frac{\sum_{i=k}^I C_i}{I}$$

where:

- C_I = depth-weighted average concentration over the entire interval I
- C_i = 95% UCL or maximum detected concentration, whichever is less, for the ith 1-ft increment
- i = specific 1-ft increment (i.e., 0 to 1 ft, 1 to 2 ft, ..., I-1 to I ft)
- I = the number of 1-ft increments.

- For PBF-21, I = 3.

Figure 4-37. PBF-21 SPERT-III large leach pond source term concentrations and assumptions for risk assessment.

4.2.6.1 PBF-22—SPERT-IV Leach Pond (PBF-758).

4.2.6.1.1 Site Description—The PBF-22 site was the location of a 5,010-m² unlined surface impoundment that received effluent from the SPERT-IV reactor from 1961 to 1970. The location of the site is shown in Figure 4-38. Effluent to the pond consisted of radioactively contaminated wastewater, emergency shower water, and demineralizer discharges. Occasional discharges from the SPERT-IV waste holdup tank were routed to the pond from 1979 to 1981. In the early 1980s, contaminated primary coolant effluents from the PBF Reactor were transported to the site by truck and emptied into the pond. In 1985, the area was surveyed, and approximately six boxes of soil were removed and transported to the RWMC.

4.2.6.1.2 Site Investigations—Approximately 62,000 L of treated PBF Reactor liquid waste were emptied into the leach pond in 1983. In a radiological survey conducted in 1985, two soil samples were collected. The survey readings were between 200 to 260 counts per minute, and no hot spots were detected. Concentrations above current background values were detected for Cs-137, Sr-90, and Co-60 at 11.1, 5.4, and 2.29 pCi/g, respectively (Hillman-Mason et al. 1994). Two separate characterizations for hazardous constituents were performed in 1988. Samples were collected from 10 locations at four depth increments, and six biased samples were collected in discharge zones (Hillman-Mason et al. 1994; see Rohe, Sondrup, and Whitaker 1996 in Appendix J). Aroclor-1254, chromium, and mercury were detected at 0.785, 147, and 0.11 mg/kg, respectively.

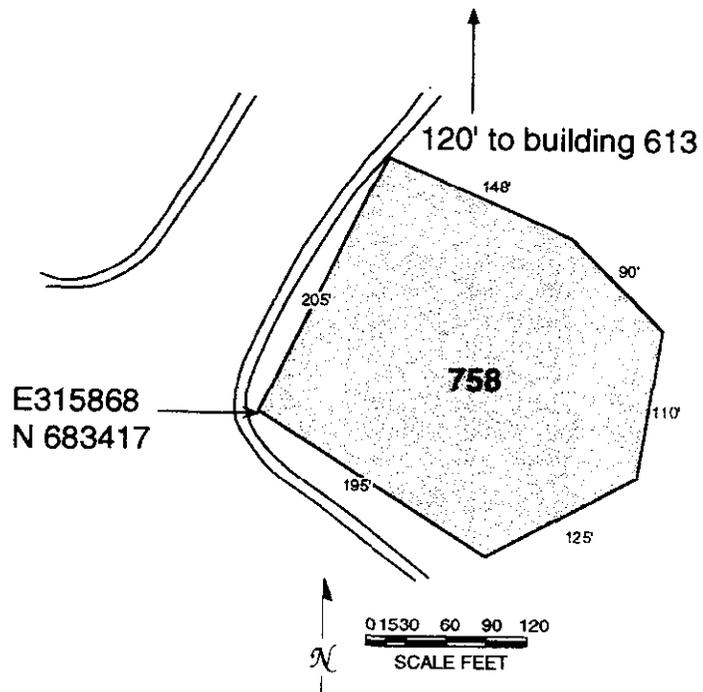
4.2.6.1.3 Nature and Extent of Contamination—Three metal and nine radionuclide contaminants were retained for analysis in the BRA as shown in Figure 4-39. Arsenic, lead, manganese, Th-228, Th-230, Th-232, U-234, and U-238 were detected in the soil profile to a depth of 10 ft. Plutonium-239 detections were limited to depths between 1 to 4 ft. Concentrations of Am-241, Cs-137, and Pu-238 were detected at depths down to 4 ft.

4.2.6.2 PBF-26—PBF SPERT-IV Lake.

4.2.6.2.1 Site Description—The PBF-26 site is a 20,150-m² surface impoundment area constructed in 1960 by raising a soil and rock dike to close off an irregularly shaped natural depression. The approximate volume of the resulting containment area is 6 million gal., and the impoundment was called a lake even though it was never used at capacity. Typically, only small quantities of water were observed over short durations. The center of the area is approximately 244 m southwest of the MWSF, as shown in Figure 4-40. From 1961 to 1970, the lake received uncontaminated cooling water from the secondary loop of the SPERT-IV reactor. After 1970 until 1985, the lake was inactive and dry except for occasional accumulations of natural precipitation. From 1985 to 1992, the only discharges to the lake were uncontaminated effluent from Three Mile Island studies and discharges generated by periodic testing of emergency eye wash and shower stations. The pipeline to the lake was removed in 1992, ending all discharges (EG&G May 1993).

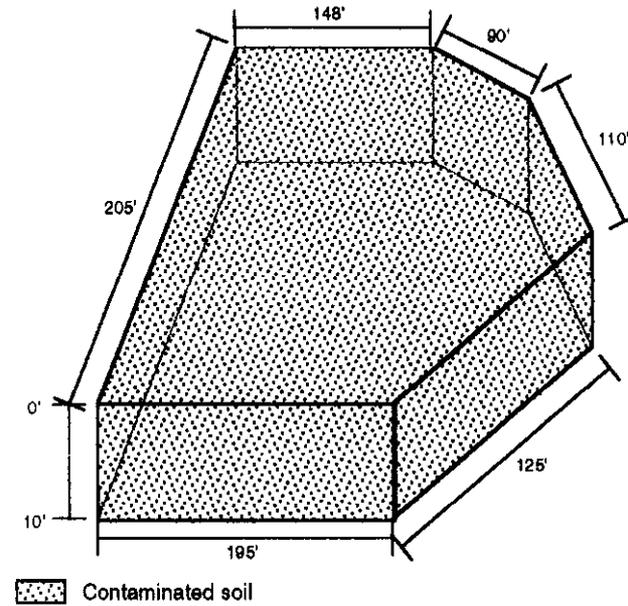
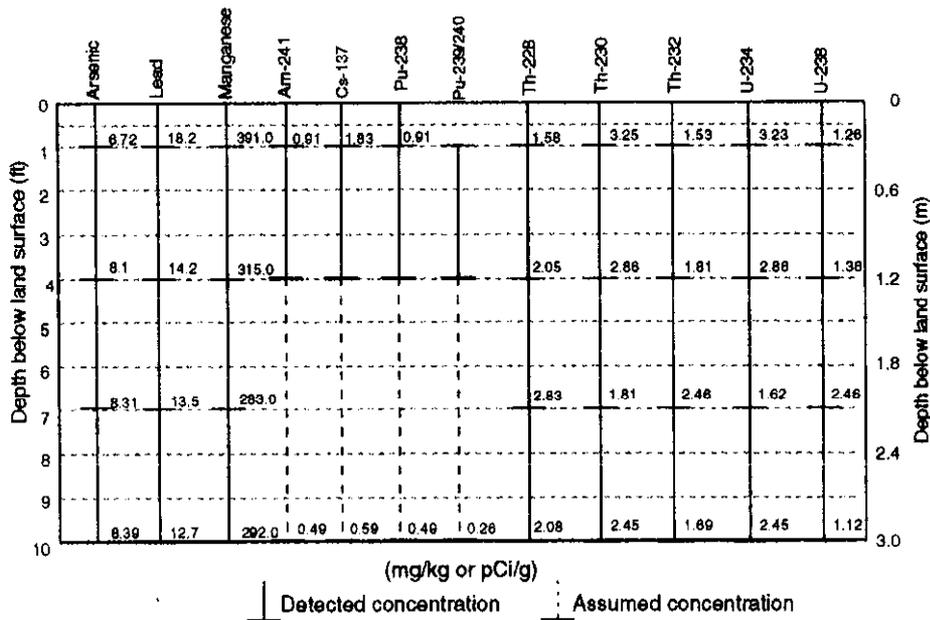
4.2.6.2.2 Site Investigations—Discharges were primarily reactor secondary cooling water containing trace levels of radionuclides and heavy metals. The lake surface soils near the discharge point were sampled in 1985 and 1988. In a second sampling effort in 1988, samples were collected at depths ranging from 0 to 5.6 ft below the surface (EG&G May 1993).

In 1985, Cs-137 was detected at 7.69 pCi/g and two samples showed elevated concentrations of Aroclor-1254. Several more samples were collected for PCB analysis in the second sampling campaign in 1988, and one sample yielded a PCB concentration. All three PCB detections occurred near the discharge point within a small channel that was formed as water flowed from the discharge pipe (EG&G May 1993).



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Figure 4-38. PBF SPERT-IV leach pond, Site PBF-22.



Source Term Concentrations							
Nonradionuclides (mg/kg)							
Depth (ft)	Arsenic	Lead	Manganese				
0-0.5	6.72E+00	1.82E+01	3.91E+02				
0-4	7.76E+00	1.52E+01	3.34E+02				
0-10	8.11E+00	1.40E+01	3.06E+02				
Radionuclides (pCi/g)							
Depth (ft)	Am-241	Cs-137	Pu-238	Pu-239/240	Th-228	Th-230	Th-232
0-0.5	9.10E-01	1.83E+00	9.10E-01	0.00E+00	1.58E+00	3.25E+00	1.53E+00
0-4	5.95E-01	8.99E-01	5.95E-01	1.95E-01	1.93E+00	2.86E+00	1.74E+00
0-10	5.32E-01	7.14E-01	5.32E-01	2.34E-01	8.82E+01	2.46E+00	1.94E+00
Radionuclides (pCi/g)							
Depth (ft)	U-234	U-238					
0-0.5	3.23E+00	1.26E+00					
0-4	2.88E+00	1.34E+00					
0-10	2.40E+00	1.61E+00					

Assumptions:

- The 53,932-ft² asymmetrical area of the site as shown above is the area of contamination.
- The vertical interval for the site is 10 ft.
- The source term volume is the area times the vertical interval: 53,932 ft² × 10 ft = 539,320 ft³.

Notes:

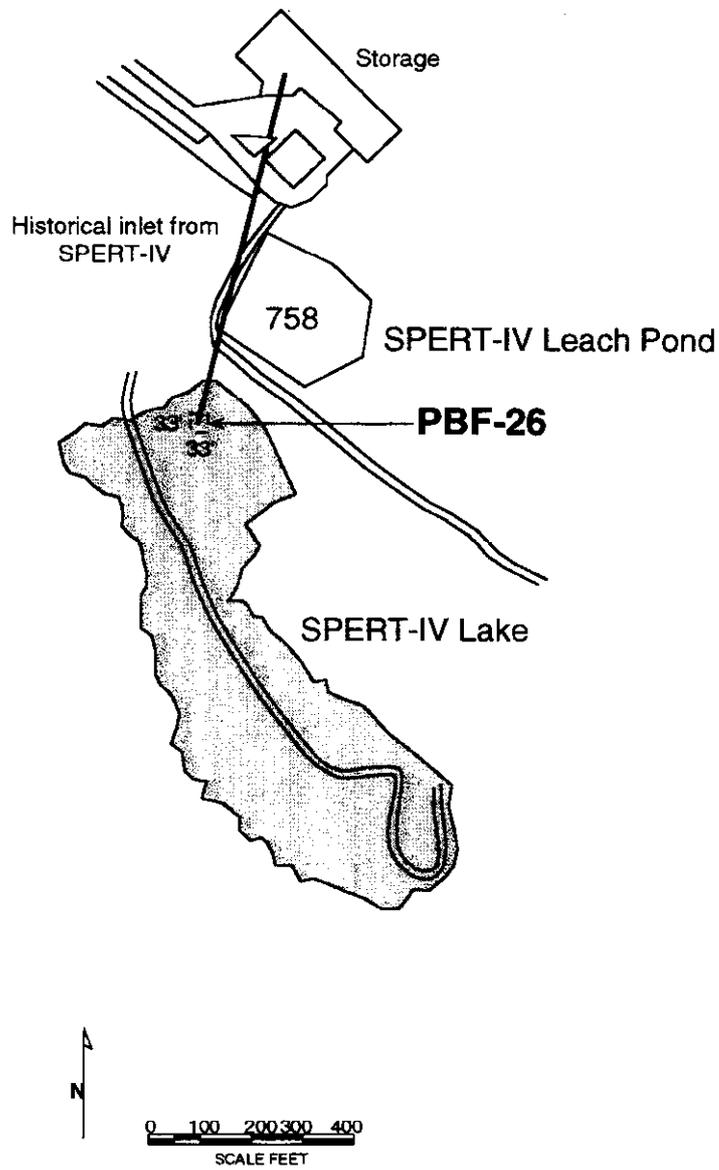
- Concentrations in the top 6 in. (0 to 0.5-ft interval) are either the 95% lognormal UCL or the maximum detected concentration, whichever is less.
- Source term concentrations below the 0 to 0.5-ft surficial sediments are depth-weighted averages calculated as follows:

$$C_I = \frac{\sum_{i=k}^I C_i}{I}$$

where:

C_i = depth-weighted average concentration over the entire interval I

Figure 4-39. PBF-22 SPERT-IV leach pond source term concentrations and assumptions for risk assessment.



WAG5JB98004

Figure 4-40. PBF SPERT-IV Lake, Site PBF-26.

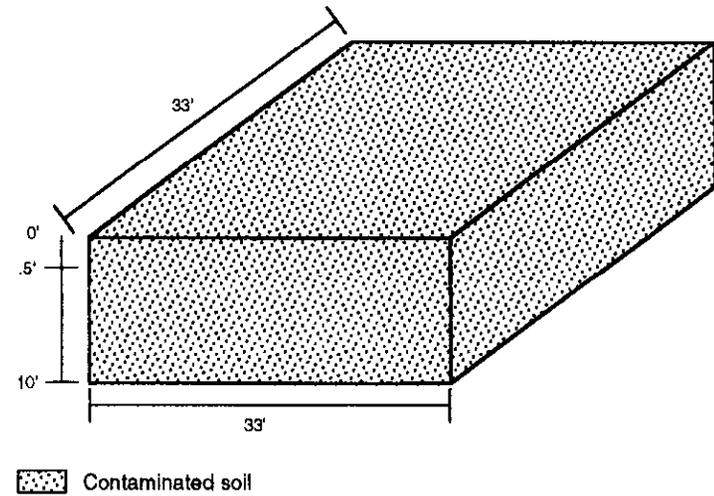
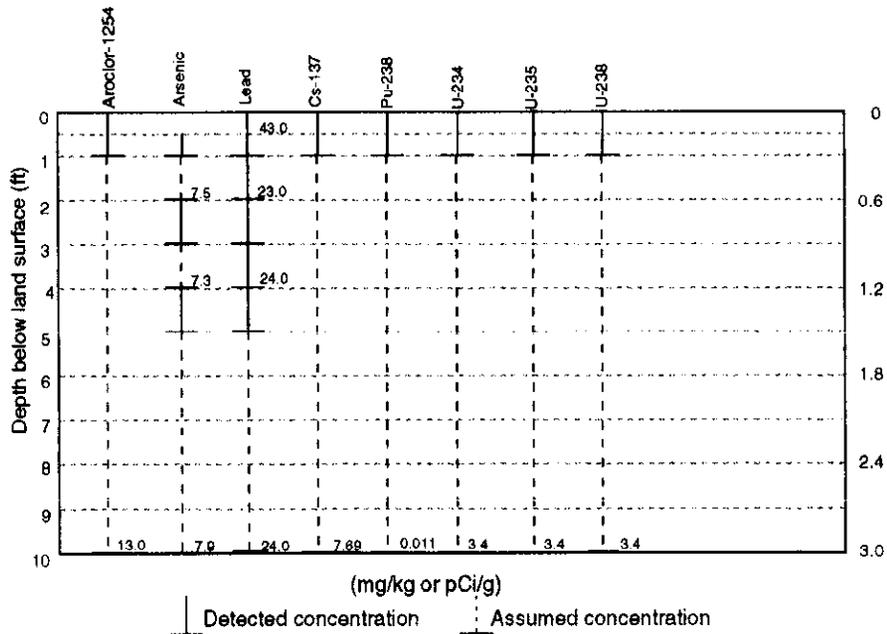
In preparation for a time critical removal action in 1995 to collect the PCB-contaminated soil (see Hiaring 1998a in Appendix J), field immunoassay for PCBs detected only one location within the channel with a possible PCB concentration greater than 10 mg/kg. However, the verification soil sample that was collected for duplicate analysis yielded a maximum PCB concentration of only 4.4 mg/kg. Five soil samples yielded Cs-137 in concentrations ranging from 0.70 to 4.7 pCi/g.

4.2.6.2.3 Nature and Extent of Contamination—The contaminants retained for quantitative analysis in the BRA include arsenic, lead, the PCB Aroclor-1254, Cs-137, Pu-238, and uranium isotopes as shown in Figure 4-41. Most detected concentrations were limited to the upper 1 ft of soil. Based on field immunoassay for PCBs and analytical results from soil samples, the contamination is assumed to be restricted to the immediate vicinity of the location of the original discharge outlet to the lake.

4.3 Groundwater Nature and Extent of Contamination

As a part of the WAG 5 hydraulic gradient evaluation (see Section 2.2.4.3), the WAG 5 groundwater monitoring network was reviewed to determine its suitability for detecting potential groundwater contamination originating within WAG 5. The review included an assessment of monitoring well locations and construction, the hydraulic gradient, and waste site locations. Of particular concern in the monitoring network review was the potential for groundwater contamination from the Warm Waste Injection Well (PBF-05) and the Corrosive Waste Injection Well (PBF-15) at the PBF Reactor Area and the SL-1 Burial Ground east of ARA-II (see Figure 4-42). The review concluded that the monitoring well ARA-MON-AQ-004 is appropriately located for detecting potential groundwater contamination from the SL-1 Burial Ground. However, the network was not adequate for detecting potential contamination from the PBF injection wells. The PBF injection wells were vadose zone injection wells with discharge depths of 33.5 m (110 ft) and 35 m (116 ft), respectively, approximately 104 m (340 ft) above the water table. The PBF-MON-AQ-001 well was located based on the estimated regional gradient to monitor the effects of the shallow injection wells on the local groundwater. However, information obtained after the well was constructed indicated that the well is not downgradient from the PBF Reactor Area and is not an adequate monitoring point for the two injection wells. Another monitoring well, PBF-MON-AQ-003, is too distant to adequately monitor downgradient contamination from the injection wells. Therefore, the SPERT-1 production well was incorporated into the monitoring network to assess the nature and extent of contamination for the WAG 5 comprehensive RI/FS. Based on the review of the monitoring network, adding the SPERT-1 production well to the monitoring network provided adequate coverage of WAG 5 and no additional wells were necessary to evaluate the nature and extent of groundwater contamination.

The nature and extent of groundwater contamination at WAG 5 were evaluated through analysis of samples collected from eight groundwater monitoring wells and the SPERT-1 production well. The PBF-MON-AQ-001, PBF-MON-AQ-003, PBF-MON-AQ-004, and PBF-MON-AQ-005 groundwater monitoring wells, abbreviated as PBF-001, PBF-003, PBF-004, and PBF-005, respectively, were installed in the vicinity of the PBF facilities. The ARA-MON-AQ-001, ARA-MON-AQ-002, ARA-MON-AQ-003A, and ARA-MON-AQ-004 groundwater monitoring wells, abbreviated as ARA-001, ARA-002, ARA-003A, and ARA-004, respectively, were installed in the vicinity of the ARA facilities. The well locations and groundwater gradient in the WAG 5 area are shown in Figure 2-12. Data from the April and July 1995 and the August 1997 sampling campaigns were used to describe the nature and extent of contamination. (Note: the PBF-004 and PBF-005 wells were not sampled in April and July 1995, and the SPERT-1 production well was included in the August 1997 sampling.) Samples were analyzed for organic, inorganic, and radiological constituents. Analytical results from these sampling events and relevant standards are summarized for the three sample campaigns in Tables 4-1, 4-2, and 4-3.



Assumptions:

- The area of the source term is limited to the area of maximum lateral spread of contamination. Based on sampling data, the area of the source term, limited to the area within 10 m (33 ft) of the pipe outlet, is 33 ft × 33 ft = 1,089 ft².
- The vertical interval for the site is 10 ft.
- Samples collected from surface soils are representative of the source volume to a depth of 10 ft.
- The source term volume is the area times the vertical interval: 1,089 ft² × 10 ft = 10,890 ft³.
- Uranium samples were analyzed for total uranium and the maximum detected concentration was assigned to all three uranium isotopes.

Notes:

- Concentrations in the top 6 in. (0 to 0.5-ft interval) are either the 95% lognormal UCL or the maximum detected concentration, whichever is less.
- Source term concentrations below the 0 to 0.5-ft surficial sediments are depth-weighted averages calculated as follows:

$$C_I = \frac{\sum_{i=k}^I C_i}{I}$$

where:

- C_I = depth-weighted average concentration over the entire interval I
- C_i = 95% UCL or maximum detected concentration, whichever is less, for the i th 1-ft increment
- i = specific 1-ft increment (i.e., 0 to 1 ft, 1 to 2 ft, ..., I-1 to I ft)
- I = the number of 1-ft increments.

- For PBF-26, I = 10.

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Source Term Concentrations					
Nonradionuclide (mg/kg)					
Depth (ft)	Aroclor-1254	Arsenic	Lead		
0-0.5	1.30E+01	0.00E+00	4.30E+01		
0-4	1.30E+01	7.40E+00	2.35E+01		
0-10	1.30E+01	7.70E+00	2.38E+01		
Radionuclide (pCi/g)					
Depth (ft)	Cs-137	Pu-238	U-234	U-235	U-238
0-0.5	7.69E+00	1.10E-02	3.40E+00	3.40E+00	3.40E+00
0-4	7.69E+00	1.10E-02	3.40E+00	3.40E+00	3.40E+00
0-10	7.69E+00	1.10E-02	3.40E+00	3.40E+00	3.40E+00

Figure 4-41. PBF-26 SPERT-IV Lake source term concentrations and assumptions for risk assessment.

Table 4-1. WAG 5 groundwater sampling results, April 1995 (LMITCO 1997).

ANALYSIS	IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	Well ARA-MON-AQ				Well PBF-MON-AQ	
				-001	-002	-003A	-004	-001	-003
				Sample Number					
				00295011 / 00295012 ^d	00295021	00295031	00295041	00295071 / 00295072 ^d	00295081
ANIONS—FILTERED (mg/L)									
Carbonate	NA	NA ^e	NA	< 2.0 / < 2.0	< 2.0	< 2.0	< 2.0	< 2.0 / < 2.0	< 2.0
Bicarbonate	NA	NA	NA	138 / 138	138	142	140	115 / 113	129
Total alkalinity	NA	NA	NA	138 / 138	138	142	140	115 / 113	129
Nitrate	10	58.0	10.0	1.4 / 1.1	1.2	1.3	1.2	0.28 / 0.29	0.64
Sulfate	250	NA	500.0	19.4 / 20.3	19.5	23.9	19.2	17.4 / 17.4	20.8
Chloride	250	NA	NA	21.1 / 20.8	19.4	22.0	22.0	17.4 / 17.3	15.7
Total dissolved solids	500	NA	NA	231 / 237	233	258	238	191 / 208	226
ANIONS—UNFILTERED (mg/L)									
Carbonate	NA	NA	NA	< 2.0 / < 2.0	< 2.0	< 2.0	< 2.0	< 2.0 / < 2.0	< 2.0
Bicarbonate	NA	NA	NA	137 / 137	137	144	138	117 / 114	131
Total alkalinity	NA	NA	NA	137 / 137	137	144	138	117 / 114	131
Nitrate	10	58.0	10.0	1.1 / 1.2	1.2	1.4	1.2	0.30 / 0.30	0.69
Sulfate	250	NA	500.0	18.9 / 17.0	18.1	22.6	20.3	18.0 / 18.2	20.8
Chloride	250	NA	NA	20.3 / 21.2	19.2	24.5	21.5	17.7 / 17.4	15.1
Total dissolved solids	500	NA	NA	242 / 226	234	274	238	188 / 202	210
SPECIFIC CONDUCTIVITY (µmhos/cm)	NA	NA	NA	381 / 374	398	423	397	308 / 305	349
PH	6.5-8.5	NA	NA	8.0 / 8.0	8.0	7.9	8.0	8.0 / 8.1	7.9
TOTAL ORGANIC HALIDES (µg/L)	NA	NA	NA	10.2 / 11.2	11.1	22.2	13.5	16.1 / 9.7	8.5
TOTAL ORGANIC CARBON (mg/L)	NA	NA	NA	1.9 / 1.0	0.67	2.2	1.1	1.8 / 1.6	1.4
METALS—FILTERED (µg/L)									
Arsenic	50	0.05 / 11 ^f	50	< 1.8 / < 1.8	< 1.8	< 1.8	< 1.8	2.5 / < 1.8	< 1.8

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Table 4-1. (continued)

ANALYSIS	IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	Well ARA-MON-AO				Well PBF-MON-AO	
				-001	-002	-003A	-004	-001	-003
				Sample Number					
				00295011 / 00295012 ^d	00295021	00295031	00295041	00295071 / 00295072 ^d	00295081
Beryllium	4	0.02	4	< 0.70 / < 0.70	< 0.70	< 0.70	< 0.70	1.3 / 1.3	1.3
Calcium	NA	NA	NA	35,900 / 36,200	34,300	38,500	41,400	26,100 / 36,100	35,700
Chromium (total)	10	180 (CrVI)	100	6.1 / 4.9	4.2	4.9	4.3	< 4.2 / 4.2	6.6
Iron	300	11,000	NA	< 12.4 / < 12.4	< 28.8	< 18.1	< 12.4	38.0 / 22.1	30.4
Lead ⁱ	15	NA	15 ^e	8.2 / 75.7^j	8.4 ^j	16.4^j	10.2 ^j	3.1 / 13.6 ^j	7.1 ^j
Magnesium	NA	NA	NA	14,900 / 15,100	14,000	16,000	17,100	10,700 / 14,700	13,400
Potassium	NA	NA	NA	3,290 / 3,400	3,230	3,800	4,440	2,460 / 3,430	2,680
Sodium	NA	NA	NA	17,800 / 17,200	16,100	18,900	19,700	7,500 / 10,200	11,800
METALS—UNFILTERED (µg/L)									
Arsenic	50	0.05 / 11 ^f	50	< 1.8 / < 1.8	< 1.8	< 1.8	< 1.8	< 1.8 / < 1.8	< 1.8
Beryllium	4	0.02	4	< 0.70 / < 0.70	< 0.70	< 0.70	< 0.70	< 0.70 / < 0.70	< 0.70
Calcium	NA	NA	NA	29,700 / 37,300	36,400	37,600	39,300	28,700 / 36,400	35,600
Chromium (total)	100	180 (CrVI)	100	6.4 / 5.5	5.3	4.3	5.5	< 4.2 / 6.3	10.0
Iron	300	11,000	NA	< 40.7 / < 25.7/	117	< 34.6	287	167 / 252	35.2
Lead	15	NA	15 ^e	15.4 / 11.8	14.4	11.6	14.0	10.2 / 20.8	4.2
Magnesium	NA	NA	NA	12,400 / 15,600	15,000	15,700	16,300	11,600 / 14,900	13,300
Potassium	NA	NA	NA	3,010 / 3,620	3,450	3,120	3,720	2,680 / 3,530	2,960
Sodium	NA	NA	NA	16,000 / 17,700	17,500	18,500	18,900	7,900 / 9,980	11,600
GROSS ALPHA (pCi/L)	15	NA	15	3.00 / 3.20	< 2.9	2.70	6.30	3.30 / 2.50	2.70
GROSS BETA (pCi/L)	4 (mrem)	NA	4 (mrem)	3.62 / 3.17	3.62	2.82	2.94	3.24 / 3.20	2.72
STRONTIUM-90 (pCi/L)	8	14	8	< 0.58 / < 0.67	< 0.59	< 0.60	< 0.61	< 0.70 / < 0.71	< 0.63
GAMMA SPECTROSCOPY (pCi/L)	NA	NA	NA	ND ^h / ND	ND	ND	ND	ND / ND	ND

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Table 4-1. (continued)

ANALYSIS				Well ARA-MON-AQ				Well PBF-MON-AQ	
	IDAPA	RBC ^b	MCL ^c	-001	-002	-003A	-004	-001	-003
	16.01.11.200 ^a			Sample Number					
	00295011 / 00295012 ^d			00295021	00295031	00295041	00295071 / 00295072 ^d	00295081	
TRITIUM (pCi/L)	20,000	390,000	20,000	< 690 / < 690	< 690	< 700	< 700	< 690 / < 690	< 690
VOLATILE ORGANIC COMPOUNDS (µg/L) ^f									
Acetone	NA	3,700	NA	2 / 1	< 10	< 10	2	<10 / <10	< 10
Toluene	1,000	750	1,000	< 5 / < 5	< 5	< 5	< 5	< 5 / 1	< 5
Xylene	10,000	12,000	10,000	< 5 / < 5	< 5	< 5	< 5	< 5 / < 5	< 5

Note: **Bolded** values indicate results that exceed the Idaho Administrative Procedures Act (IDAPA) 16.01.11.200, "Groundwater Quality Standards"; the risk-based concentration (RBC); or the maximum concentration limit (MCL) for the contaminant.

a. IDAPA 16.01.11.200, "Groundwater Quality Standards"

b. RBC means risk-based concentration in water.

c. MCL means maximum concentration limit.

d. Duplicate samples were collected during April 1995 and July 1995 and are listed as sample / duplicate.

e. NA means data are not available.

f. The RBC for arsenic is presented as carcinogenic risk / noncarcinogenic risk, respectively. Risk-based concentrations are based on a risk of 1E-06 for carcinogens and a hazard quotient of 1 for noncarcinogens (DOE-ID 1994).

g. An MCL has not been established for lead; however, the U.S. Environmental Protection Agency has established an "Action Level" for lead of 15 µg/L in drinking water.

h. ND means not detected.

i. Only those volatile organic compounds that were detected in at least one sample are listed.

j. The relative percent difference (RPD) for field duplicate samples analyzed for dissolved lead are excessively high. Field duplicates from ARA-001 and PBF-001 had RPDs for dissolved lead of 161% and 126%, respectively. This is an indication of poor precision in the dissolved lead analyses from this sampling event.

Table 4-2. WAG 5 groundwater sampling results, July 1995 (LMITCO 1997).

ANALYSIS	IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	Well ARA-MON-AQ				Well PBF-MON-AQ	
				-001	-002	-003A	-004	-001	-003
				Sample Number					
				05095011 / 05095012 ^d	05095021	05095031	05095041	05095071 / 05095072 ^d	05095081
ANIONS—FILTERED (mg/L)									
Carbonate	NA	NA ^e	NA	< 2.0 / < 2.0	< 2.0	< 2.0	< 2.0	< 2.0 / < 2.0	< 2.0
Bicarbonate	NA	NA	NA	136 / 135	135	142	137	118 / 120	132
Total alkalinity	NA	NA	NA	136 / 135	135	142	137	118 / 120	132
Nitrate	10	58.0	10.0	1.2 / 1.2	1.2	1.4	1.2	0.34 / 0.34	0.67
Sulfate	250	NA	500.0	20.3 / 21.1	21.2	22.9	20.1	18.9 / 18.2	23.8
Chloride	250	NA	NA	18.9 / 19.2	19.4	21.7	19.0	16.2 / 16.3	13.6
Total dissolved solids	500	NA	NA	222 / 228	NA	238	218	186 / 200	226
ANIONS—UNFILTERED (mg/L)									
Carbonate	NA	NA	NA	< 2.0 / < 2.0	< 2.0	< 2.0	< 2.0	< 2.0 / < 2.0	< 2.0
Bicarbonate	NA	NA	NA	137 / 137	138	142	136	118 / 120	132
Total alkalinity	NA	NA	NA	137 / 137	138	142	136	118 / 120	132
Nitrate	10	58.0	10.0	1.2 / 1.2	1.2	1.4	1.2	0.35 / 0.36	0.67
Sulfate	250	NA	500.0	20.2 / 20.1	21.3	23.4	20.8	19.5 / 20.7	22.4
Chloride	250	NA	NA	18.7 / 19.0	18.8	21.7	19.3	17.0 / 16.6	13.6
Total dissolved solids	500	NA	NA	182 / 1240	234	251	245	202 / 195	225
SPECIFIC CONDUCTIVITY (µmhos/cm)	NA	NA	NA	374 / 376	368	400	379	325 / 321	350
PH	6.5-8.5	NA	NA	8.1 / 8.2	8.5	8.0	7.7	8.1 / 8.4	8.1
TOTAL ORGANIC HALIDES (µg/L)	NA	NA	NA	14.3 / 6.6	17.1	10.5	11.7	27.9 / 13.4	26.5
TOTAL ORGANIC CARBON (mg/L)	NA	NA	NA	0.88 / 0.98	< 0.50	0.88	0.79	0.70 / 0.60	0.51
METALS—FILTERED (µg/L)									
Arsenic	50	0.05 / 11 ^f	50	< 4.1 / < 2.5	< 1.6	< 3.1	< 3.2	2.8 / 2.2	3.0
Beryllium	4	0.02	4	< 0.70 / < 0.70	< 0.40	< 0.70	< 0.70	< 0.70 / < 0.70	< 0.70

Table 4-2. (continued).

ANALYSIS	IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	Well ARA-MON-AQ			Well PBF-MON-AQ		
				-001	-002	-003A	-004	-001	-003
				Sample Number					
				05095011 / 05095012 ^d	05095021	05095031	05095041	05095071 / 05095072 ^d	05095081
Calcium	NA	NA	NA	32,800 / 33,800	34,500	34,600	33,300	30,800 / 30,900	36,200
Chromium (total)	100	180 (CrVI)	100	< 2.7 / 3.1	< 9.7	3.4	2.8	2.8 / 4.8	5.2
Iron	300	11,000	NA	< 15.6 / < 15.6	< 31.5	15.6	< 15.6	< 15.6 / < 15.6	< 15.6
Lead	15	NA	15 ^e	7.8 / 6.3	9.2	11.4	7.9	< 1.0 / 1.7	< 1.0
Magnesium	NA	NA	NA	13,800 / 14,200	14,200	14,400	13,900	12,400 / 12,300	13,700
Potassium	NA	NA	NA	3,280 / 3,540	3,630	3,500	3,470	2,580 / 2,550	2,800
Sodium	NA	NA	NA	16,000 / 16,600	16,000	17,300	16,500	8,470 / 8,360	12,000
METALS—UNFILTERED (µg/L)									
Arsenic	50	0.05 / 11 ^f	50	< 4.8 / < 2.0	< 1.6	< 3.9	< 2.0	< 2.0 / < 2.0	3.7
Beryllium	4	0.02	4	< 0.70 / < 0.70	< 0.40	< 0.70	< 0.70	< 0.70 / < 0.70	< 0.70
Calcium	NA	NA	NA	32,800 / 32,600	33,900	35,200	33,500	33,000 / 31,700	34,400
Chromium (total)	100	180 (CrVI)	100	< 2.7 / < 2.7	< 9.7	< 2.7	< 2.7	5.5 / 4.5	9.6
Iron	300	11,000	NA	< 15.6 / < 15.6	< 81.2	44.5	616	475 / 494	24.6
Lead	15	NA	15 ^e	8.7 / 9.1	13.2	13.1	16.8	3.5 / 1.8	< 1.0
Magnesium	NA	NA	NA	14,000 / 13,700	13,900	14,800	13,900	13,200 / 12,800	13,100
Potassium	NA	NA	NA	3,690 / 3,320	3,350	3,390	3,280	2,400 / 2,440	2,180
Sodium	NA	NA	NA	16,700 / 16,000	15,800	17,600	16,300	8,670 / 8,560	11,600
GROSS ALPHA (pCi/L)	15	NA	15	3.30 / 4.30	< 2.5	< 2.8	< 2.7	< 2.7 / < 3.2	< 2.6
GROSS BETA (pCi/L)	4 (mrem)	NA	4 (mrem)	4.62 / 4.04	< 2.5	4.50	2.99	3.80 / 3.14	< 2.9
STRONTIUM-90 (pCi/L)	8	14	8	< 0.60 / < 0.59	< 0.64	< 0.56	< 0.54	< 0.62 / < 0.60	< 0.56
GAMMA SPECTROSCOPY (pCi/L)	NA	NA	NA	ND ^h / ND	ND	ND	ND	ND / ND	ND
TRITIUM (pCi/L)	20,000	390,000	20,000	< 430 / < 430	< 700	< 430	< 430	< 430 / < 430	< 430

Table 4-2. (continued).

ANALYSIS	IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	Well ARA-MON-AQ				Well PBF-MON-AQ	
				-001	-002	-003A	-004	-001	-003
				Sample Number					
				05095011 / 05095012 ^d	05095021	05095031	05095041	05095071 / 05095072 ^d	05095081
VOLATILE ORGANIC COMPOUNDS (µg/L)^f									
Carbon disulfide	NA	1,000	NA	< 5 / < 5	< 5	< 5	< 5	3 / < 5	< 5

Note: **Bolded** values indicate results that exceed Idaho Administrative Procedures Act (IDAPA) 16.01.11.200, "Groundwater Quality Standards"; the RBC; or the MCL for the contaminant.

- a. IDAPA 16.01.11.200, "Groundwater Quality Standards"
- b. RBC means risk-based concentration in water.
- c. MCL means maximum concentration limit.
- d. Duplicate samples were collected during April 1995 and July 1995 and are listed as sample / duplicate.
- e. NA means data are not available.
- f. The RBC for arsenic is presented as carcinogenic risk / noncarcinogenic risk, respectively. Risk-based concentrations are based on a risk of 1E-06 for carcinogens and a hazard quotient of 1 for noncarcinogens (DOE-ID 1994).
- g. An MCL has not been established for lead; however, the U.S. Environmental Protection Agency has established an "Action Level" for lead of 15 µg/L in drinking water.
- h. ND means not detected.
- i. Only volatile organic compounds that were detected in at least one sample are listed.

Table 4-3. WAG 5 groundwater sampling results, August 1997 (LMITCO 1997).

ANALYSIS	Well ARA-MON-AQ			Well PBF-MON-AQ							
				-001	-002	-003A	-004	-001	-003	-004	-005
	IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	Sample Number							
			5GW10101	5GW10201	5GW10301	5GW10401	5GW10501	5GW10601	5GW10701 / 5GW10702 ^d	5GW10801	
HYDRAZINE (µg/L)	NA	0.02	NA ^e	NR ^f	NR	NR	NR	< 0.050	NR	< 0.050 / < 0.050	NR
ANIONS (mg/L)											
Chloride	250	NA	NA	19.32	19.25	22.27	21.04	17.77	14.24	13.35 / 13.54	15.08
Sulfate	250	NA	500	19.06	18.80	20.63	20.22	17.4	22.51	16.18 / 16.22	21.08
Bromide	NA	NA	NA	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2 / < 0.2	< 0.2
Fluoride	4	2.2	4	0.511	0.521	0.481	0.542	0.275	0.319	< 0.2 / < 0.2	0.25
Nitrite	1	3.7	1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2 / < 0.2	< 0.2
Nitrate	10	58	10	1.14	1.15	1.29	1.08	0.39	0.66	0.51 / 0.51	0.69
Phosphate	NA	NA	NA	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.5 / < 0.5	< 0.2
CONTRACT LABORATORY PROGRAM (CLP) METALS—unfiltered (µg/L)											
Aluminum	NA	37,000	NA	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0 / < 50.0	< 50.0
Antimony	6	10	6	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0 / < 50.0	< 50.0
Arsenic	50	0.05 / 11 ^g	50	2.9	< 2.5	2.6	3.4	< 2.5	< 2.5	< 2.5 / < 2.5	< 2.5
Barium	2,000	2,600	2,000	37.6	36.5	42.1	34.9	37.1	51.8	25.2 / 25.1	43.0
Beryllium	4	0.02	4	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0 / < 4.0	< 4.0
Cadmium	5	18	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0 / < 5.0	< 5.0
Calcium	NA	NA	NA	35,400	35,600	37,500	34,400	33,800	38,200	31,800 / 31,700	40,400
Chromium (total)	100	180 (CrVI)	100	< 10.0	< 10.0	< 10.0	37.0	< 10.0	16.5	< 10.0 / < 10.0	< 10.0
Cobalt	NA	2,200	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0 / < 10.0	< 10.0
Copper	1,300	130,000	1,300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0 / < 5.0	< 5.0
Iron	300	11,000	NA	95.5	61.2	109	16,600	320	62.0	< 10.0 / < 10.0	171
Lead	15	NA	15 ^h	13.8	13.0	22.2	49.2	9.4	< 2.0	11.2 / 11.2	12.7
Magnesium	NA	NA	NA	14,500	14,400	15,600	14,200	13,800	14,100	13,300 / 13,200	14,900
Manganese	50	840	NA	< 2.5	< 2.5	2.8	33.5	14.3	< 2.5	< 2.5 / < 2.5	5.2
Mercury	2	11	2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2 / < 0.2	< 0.1

Table 4-3. (continued).

ANALYSIS				Well ARA-MON-AQ				Well PBF-MON-AQ			
				-001	-002	-003A	-004	-001	-003	-004	-005
	IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	Sample Number							
				5GW10101	5GW10201	5GW10301	5GW10401	5GW10501	5GW10601	5GW10701 / 5GW10702 ^d	5GW10801
Nickel	NA	730	140	< 15.0	< 15.0	< 15.0	22.0	< 15.0	< 15.0	< 15.0 / < 15.0	< 15.0
Potassium	NA	NA	NA	3,430	3,570	3,490	3,290	2,390	3,080	1,930 / 1,890	2,430
Selenium	50	180	50	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5 / < 2.5	< 2.5
Silver	100	180	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0 / < 5.0	< 5.0
Sodium	NA	NA	NA	16,600	16,700	18,300	16,600	8,680	12,100	9,310 / 9,230	8,290
Thallium	2	NA	2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0 / < 2.0	< 2.0
Vanadium	NA	260	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0 / < 10.0	< 10.0
Zinc	5,000	11,000	NA	634	694	1,110	4,030	955	38.9	609 / 605	998
POLYCHLORINATED BIPHENYLS (µg/l.)	0.5	0.03	0.5	NR	NR	NR	NR	NR	ND ^f	ND / ND	NR
GROSS ALPHA (pCi/L)	15	NA	15	< 1.54	2.42	< 1.77	1.68	< 1.92	< 2.07	< 2.49 / < 2.36	< 2.00
GROSS BETA (pCi/L)	4 (mrem)	NA	4 (mrem)	2.71	3.86	< 2.77	3.25	< 3.17	< 2.87	< 3.14 / < 3.84	< 2.96
ALPHA SPECTROSCOPY (pCi/L)	NA	NA	NA	NR	NR	NR	NR	NR	NR	NR / NR	NR
STRONTIUM-90 (pCi/L) ^g	8	14	8	NR	NR	NR	NR	NR	NR	NR / NR	NR
TECHNETIUM -99 (pCi/L) ^g	NA	34	NA	NR	NR	NR	NR	NR	NR	NR / NR	NR
GAMMA SPECTROSCOPY (pCi/L)	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND / ND	ND
TRITIUM (pCi/L)	20,000	390,000	20,000	< 367	< 367	< 367	< 367	< 368	< 368	5,010 / < 354	< 368
IODINE-129 (pCi/L)	NA	0.26	NA	< 1.88	< 1.68	< 2.22	< 2.27	< 2.10	< 1.83	< 1.8 / < 1.82	< 1.84

Table 4-3. (continued).

ANALYSIS	Well ARA-MON-AQ				Well PBF-MON-AQ						
	-001	-002	-003A	-004	-001	-003	-004	-005			
	Sample Number										
IDAPA 16.01.11.200 ^a	RBC ^b	MCL ^c	5GW10101	5GW10201	5GW10301	5GW10401	5GW10501	5GW10601	5GW10701 / 5GW10702 ^d	5GW10801	
VOLATILE ORGANIC COMPOUNDS (µg/L) ^j											
Toluene	1,000	750	1,000	< 5	< 5	< 5	< 5	< 5	< 5	3 / 3	< 5

Note: **Bolded** values indicate results that exceed Idaho Administrative Procedures Act (IDAPA) 16.01.11.200, "Groundwater Quality Standards"; the RBC, or the MCL for the contaminant.

- a. IDAPA 16.01.11.200, "Groundwater Quality Standards"
- b. RBC means risk-based concentration in water.
- c. MCL means maximum concentration limit.
- d. Duplicate samples were collected during April 1995 and July 1995 and are listed as sample / duplicate.
- e. NA means data are not available.
- f. NR means data are not analyzed or reported.
- g. The RBC for arsenic is presented as carcinogenic / noncarcinogenic risk, respectively. Risk-based concentrations are based on a risk of 1E-06 for carcinogens and a hazard quotient of 1 for noncarcinogens (DOE-ID 1994).
- h. An MCL has not been established for lead; however, the U.S. Environmental Protection Agency has established an "Action Level" for lead of 15 µg/L in drinking water.
- i. ND means not detected.
- j. Only volatile organic compounds that were detected in at least one sample are listed.
- k. Strontium-90 and Tc-99 were not analyzed because no gross-beta results for any of the samples exceeded 5 pCi/L, the level determined in the WAG 5 Sampling and Analysis Plan (DOE-ID 1997) to require analysis for the two radionuclides.

Because the April and July 1995 groundwater samples were collected by the INEEL Environmental Monitoring Program, they were not initially validated to quality Level A, typically used for Environmental Restoration Program RI/FS sampling results. These sample results were resubmitted for validation as part of the WAG 5 RI/FS. With the exception of radiological analyses, all results were subsequently validated to a Level A. Radiological analyses were validated to Levels A, B, or C depending on the amount of information available. The August 1997 samples, collected specifically for the WAG 5 RI/FS, were validated to Level A.

The results from the groundwater sampling were compared against risk-based concentrations (RBCs) developed by the EPA (1997) and the state of Idaho (Fromm 1996), maximum contaminant levels (MCLs) (EPA 1996), and Idaho groundwater quality standards (IDAPA 16.01.11.200). Of the analytes tested, beryllium, iron, arsenic, and lead were detected in at least one groundwater sample at concentrations exceeding either the RBC or MCL. These contaminants are discussed in the following paragraphs. Groundwater concentrations predicted by transport modeling of contaminants in the vadose zone to groundwater are discussed in Section 5.

4.3.1 Beryllium in Groundwater

The April 1995 sampling yielded beryllium concentrations greater than the RBC of 0.02 µg/L but below the MCL and Idaho groundwater quality standard of 4 µg/L in three filtered samples collected from monitoring Wells PBF-001 (from which a duplicate sample was taken) and PBF-003. As shown in Table 4-1, the primary and duplicate samples from the PBF-001 well the PBF-003 sample each had a concentration of 1.3 µg/L.

However, the April 1995 beryllium results are questionable because the beryllium concentrations in accompanying unfiltered samples from the same wells were all below the detection level of 0.7 µg/L. Typically, total or unfiltered metal results are expected to equal or exceed concurrently collected filtered samples. Beryllium was not detected in subsequent sampling of PBF-001 and PBF-003 during July 1995. There are no known elevated beryllium concentrations in soils that could be acting as a source for beryllium in groundwater near Well ARA-004, (see Section 4.2.1 for a discussion of the nature and extent of soil contamination in Group 1, ARA-I and -II). The detection of beryllium in PBF-001 and (1) unusual quantities were reported, (2) the accompanying unfiltered samples were all nondetects for beryllium, and (3) all results, both filtered and unfiltered, were nondetects in subsequent sampling. Current beryllium concentrations in groundwater are, therefore, not attributed to sources within WAG 5.

4.3.2 Iron in Groundwater

The Idaho groundwater quality standard for iron, based on aesthetics, is 300 µg/L (IDAPA 16.01.11.200) and the RBC for iron is 11,000 µg/L (EPA 1997). An MCL has not been established for iron. The Idaho standard was exceeded in total (unfiltered) iron samples collected from ARA-004 and PBF-001 in July 1995 and August 1997; however, the dissolved iron concentrations were well below the Idaho standard. The range of dissolved concentrations in ARA-004 and PBF-001 is from 38 µg/L to less than the detection limit. The RBC was exceeded in the August 97 unfiltered sample from ARA-004 with a concentration of 16,000 µg/L (see Table 4-3).

The 16,000 µg/L iron concentration reported in Well ARA-004 appears anomalously high relative to previous sampling events. Unfiltered samples from April and July 1995 contained dissolved iron concentrations of 287 and 616 µg/L, respectively (see Table 4-1 and 4-2). The elevated iron concentration observed in the August 1997 sample from ARA-004 may have been caused either by laboratory error or by corrosion of the galvanized steel riser pipe used in the well for groundwater sampling. Corrosion of the riser pipe and flaking of the resulting iron oxides could introduce iron oxides into the groundwater sample,

causing the dissolved iron concentrations in ARA-004 to appear high. Iron concentrations in soils that could act as a source of the high iron concentrations in groundwater are not identified with WAG 5 sites.

Based on previous lower iron concentrations reported for Well ARA-004 and the potential for sample contamination from the riser material, the high iron concentration reported in the August 1997 sampling event is considered an anomaly and not representative of true groundwater concentrations. Therefore, current concentrations in groundwater are not attributed to sources within WAG 5.

4.3.3 Arsenic in Groundwater

Arsenic has been detected in groundwater samples from WAG 5 at concentrations exceeding the carcinogenic RBC of 0.05 µg/L but below the noncarcinogenic RBC of 11 µg/L and the MCL and Idaho standard of 50 µg/L. Arsenic was detected in the April 1995 filtered sample from Well PBF-001, but not in the accompanying unfiltered sample (see Table 4-1). Detections occurred again in samples collected in July 1995 in the filtered samples from Well PBF-001, from which a duplicate sample was taken, and from PBF-003. However, arsenic was detected only in the unfiltered sample from PBF-003 during the July 1995 sampling (see Table 4-2). Detection occurred in unfiltered samples from Wells ARA-001, ARA-003A, and ARA-004 during the August 1997 sampling (see Table 4-3). The maximum concentration observed was 3.7 µg/L in the unfiltered sample collected in July 1995 from PBF-003.

Arsenic, however, is a ubiquitous element in the soils and basalt rock at the INEEL. The estimated background concentration of dissolved arsenic in groundwater at the INEEL developed by the U.S. Geological Survey (USGS) is approximately 2 to 3 µg/L (Orr, Cecil, and Knobel 1991). Because all of the detections of arsenic (both dissolved and total) in groundwater samples fall within the established background concentrations of dissolved arsenic, existing arsenic in groundwater at WAG 5 is considered to be naturally occurring.

4.3.4 Lead in Groundwater

Neither an RBC nor an MCL has been calculated for lead (dissolved or total) in groundwater because lead toxicity data have not been developed. However, the EPA has established an action level for lead concentration at the tap, or faucet, of 15 µg/L (EPA 1996). The Idaho groundwater quality standard for lead also is 15 µg/L (IDAPA 16.01.11.200). Three wells in the ARA area (ARA-001, -003A, and -004) and two wells in the PBF area (PBF-001, and SPERT-1) had at least one ground water sample with either total (unfiltered sample) or dissolved (filtered sample) lead concentrations exceeding 15 µg/L (see Tables 4-1, 4-2, and 4-3). A total of eight samples from these five wells contained lead concentrations exceeding 15 µg/L, though only two of those eight samples were dissolved lead samples. Because the results indicated potential groundwater contamination, they are discussed in more detail below.

4.3.4.1 Occurrence of Dissolved Lead. The two dissolved lead samples exceeding the action level were obtained in the April 1995 sampling of monitoring Wells ARA-001 and ARA-003A. Dissolved lead concentrations were 75.7 µg/L and 16.4 µg/L, respectively. However, because the duplicate dissolved lead sample from Well ARA-001 had a concentration of only 8.2 µg/L (see Table 4-1), almost an order of magnitude less, data from Well ARA-001 are considered spurious and are not used in this evaluation. It also should be noted that both field duplicate samples collected from Wells ARA-001 and PBF-001 in April 1995 (see Table 4-1) had a high relative percent difference (RPD) for dissolved lead analyses. The RPDs were 161% and 126%, respectively. The high RPD is a possible indication of poor precision in dissolved lead analyses for the entire April 1995 data set.

A comparison of dissolved lead to USGS calculated background concentrations shows that with the exception of Well PBF-003 (and possibly PBF-004 and PBF-005 for which dissolved lead data are not available), the mean dissolved lead concentrations from WAG 5 monitoring wells exceed the estimated INEEL-wide background concentration of more than 5 µg/L in groundwater (Orr, Cecil, and Knoble 1991). The USGS background concentration is calculated from dissolved lead analyses. The calculated 95% upper confidence level estimates for mean concentrations (95% upper confidence level [UCL]) for dissolved lead concentrations in WAG 5 monitoring wells are presented in Table 4-4. In all cases for which a 95% UCL could be calculated, the maximum dissolved lead concentration is less than the calculated 95% UCL. Therefore, the maximum concentrations were used for the description of the extent of contamination instead of the 95% UCL values.

Mean and maximum dissolved lead concentrations are plotted on Figure 4-42. After eliminating the spurious Well ARA-I results, only ARA-003A has a maximum dissolved lead concentration in excess of the 15 µg/L action level. Because of the few samples, the statistical significance of this occurrence is unclear.

In an effort to further evaluate the significance of these data and to determine whether dissolved lead concentrations in the WAG 5 monitoring wells are on average greater than background concentrations, the full data set from the WAG 5 wells (RI/FS samples) was compared to available USGS dissolved lead data from 13 surrounding wells. The USGS data from local wells surrounding WAG 5 were obtained from the USGS groundwater database (USGS 1998) maintained at their office at the Central Facilities Area at the INEEL. These data are presented in Table 4-5 and plotted on Figure 4-42. As with the RI/FS data, all calculated 95% UCLs from the USGS data were greater than the maximum; therefore, the maximum values are plotted.

The mean dissolved lead concentrations from all samples collected from the USGS background wells were statistically compared to the mean dissolved lead concentration from the all WAG 5 groundwater samples using a standard Student-T test for the two sample populations (Devore and Peck 1990). The 31 samples from the 13 USGS monitoring wells have an arithmetic mean value of 3.4 µg/L with a standard deviation of 3.7 µg/L. The 14 RI/FS dissolved lead samples collected from six wells have a mean concentration of 7.4 µg/L with a standard deviation of 4.8 µg/L. Though the mean dissolved lead concentration from the WAG 5 monitoring well samples is greater than the mean from local USGS background wells, statistical comparison of these two sample populations indicates that, given the variability in the data, the two populations are not statistically different at the 95% confidence level. Based on the statistical comparison of the USGS data set to the WAG 5 data set, the average dissolved lead concentrations beneath WAG 5 are not statistically greater than background.

4.3.4.2 Occurrence of Total Lead. Total lead, or unfiltered lead samples, have shown, as expected, a higher frequency of detection exceeding the 15 µg/L action level. The wells with one or more samples with total lead concentrations exceeding 15 µg/L included ARA-001, ARA-003A, ARA-004, PBF-001, and SPERT-1. These data with calculated 95% UCLs are included in Table 4-6. Though these results appear to be relatively high, with the exception of the SPERT-1 well, no local background data are available for comparison because all of the USGS lead analyses have been performed on filtered samples. Therefore, it cannot be determined whether these results are anomalous and indicate some form of contamination or whether the concentrations are naturally occurring.

Previous sampling of the SPERT-1 well by the USGS from 1984 through 1987 indicated dissolved concentrations well below the action level (see Table 4-5 and Figure 42). The drinking water within the WAG 5 area supplied by the SPERT-1 well also has been monitored through the INEEL Drinking Water Program. Elevated lead concentrations in drinking water have not been reported by this program, which is responsible for complying with drinking water regulations. As with some of the other high lead values reported (e.g., for Wells ARA-001 and ARA-003A), the SPERT-1 data appear to be spurious.

Table 4-4. Filtered dissolved lead concentrations in groundwater at WAG 5 (LMITCO 1997) with calculated 95% upper confidence level estimates of mean concentrations.

Well	Date	Sample Data			Calculation of 95% Upper Confidence Level Assuming a Normal Distribution				
		Concentration (µg/L)	QA/QC Flags	Maximum (µg/L)	Sample Count	Arithmetic Mean (µg/L)	Standard Deviation (µg/L)	T Statistic (µg/L)	95% UCL (µg/L)
ARA-MON-AQ-001	April 95	8.2/75.7 ^{a,b}		7.8	2	7.1	1.06	12.71	16.58
	July 95	7.8/6.3 ^a							
ARA-MON-AQ-002	April 95	8.4	NJ ^c	9.2	2	8.8	0.57	12.71	13.88
	July 95	9.2	J ^d						
ARA-MON-AQ-003A	April 95	16.4		16.4	2	13.9	3.54	12.71	45.68
	July 95	11.4							
ARA-MON-AQ-004	April 95	10.2		10.2	2	9.1	1.63	12.71	23.67
	July 95	7.9							
PBF-MON-AQ-001	April 95	3.1/13.6 ^a	J/J	13.6	4	4.7	6.01	3.18	14.28
	July 95	1.0/1.7 ^a	U ^e /J						
	July 95	1.7	J						
PBF-MON-AQ-003	April 95	7.1	J	7.1	2	3.8	4.67	12.71	45.74
	July 95	1.0	U						
PBF-MON-AQ-004 ^f	NA	NA		NA	NA	NA	NA	NA	NA
PBF-MON-AQ-005 ^f	NA	NA		NA	NA	NA	NA	NA	NA
SPERT-I ^f	NA	NA		NA	NA	NA	NA	NA	NA

a. Duplicate samples were collected during April 1995 and July 1995 and are listed as sample / duplicate.

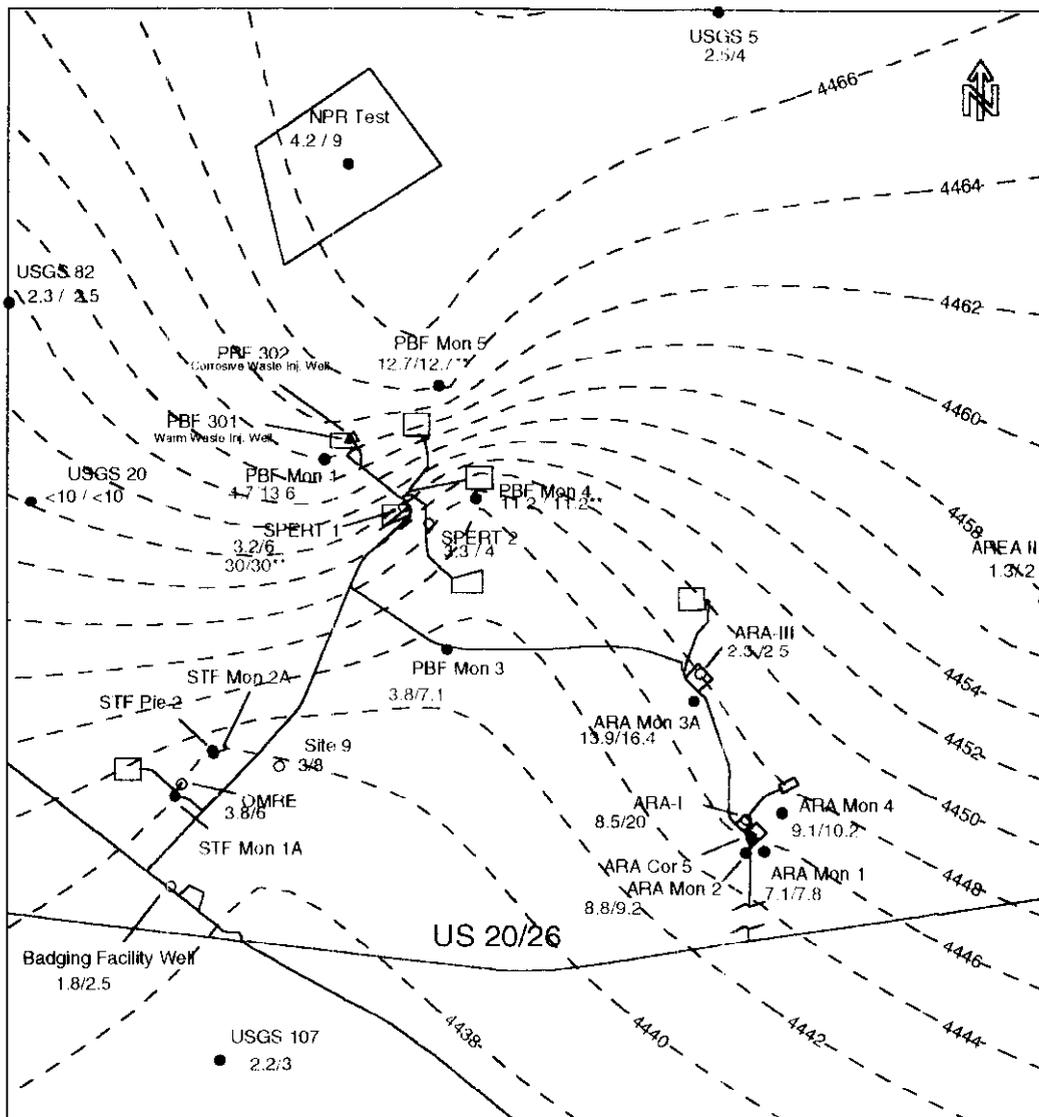
b. Because of the extreme outlier value and large difference between these two duplicate samples, the values were not included in the upper confidence level (UCL) calculations.

c. NJ indicates presumptive evidence of the presence of the analyte at an estimated quantity.

d. J indicates that the analyte was positively identified, but the associated numerical value may not be an accurate representation of the amount actually present.

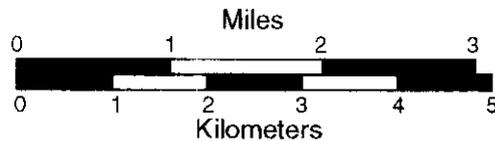
e. U indicates that the material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

f. Filtered sample data not available.



EXPLANATION

- Individual Facility
- Aquifer Well (data used in contouring)
- Aquifer Well (data unavailable or not used in contouring)
- △ Shallow Injection Well
- - - 4438 - - - March 1997 Water Level Contours
- Improved Road
- 7.1/7.8 Validated Dissolved Lead Concentrations: Mean/Maximum* in µg/L
- 3/9 USGS Dissolved Lead Concentrations: Mean/Maximum* in µg/L



*Note: 95%UCLs were calculated for all data. However, in all cases, due to the small number of samples, the UCL exceeded the maximum.
 **Dissolved lead concentrations were not available for PBF MON 4, PBF MON 5, and SPERT 1. Total lead values are plotted for these wells.

Figure 4-42. Mean and maximum dissolved lead concentrations in groundwater at WAG 5.

Table 4-5. U.S. Geological Survey dissolved lead concentrations in groundwater at WAG 5 (USGS 1998) with calculated 95% upper confidence level estimates of mean concentrations.

Well	Date	Sample Data			Calculation of 95% Upper Confidence Level Assuming a Normal Distribution			
		Concentration (µg/L)	Maximum (µg/L)	Sample Count	Arithmetic Mean (µg/L)	Standard Deviation (µg/L)	T Statistic (µg/L)	95% UCL (µg/L)
ARA-I	10/12/84	20	20	3	8.5	9.96	4.30	33.23
	8/6/85	3						
	10/28/87	< 5 ^a						
ARA-III	11/6/84	2	2.5	2	2.3	0.35	12.71	5.43
	10/28/87	< 5 ^a						
AREA II	10/26/84	2	2	2	1.3	1.06	12.71	10.78
	9/20/90	< 1 ^a						
Badging Facility	8/6/85	1	2.5	2	1.8	1.06	12.71	11.28
	10/24/87	< 5 ^a						
NPR-Test	4/28/86	9	9	3	4.2	4.25	4.30	14.72
	10/15/87	< 5 ^a						
	6/20/91	1						
OMRE	10/12/84	6	6	3	3.8	1.89	4.30	8.53
	9/9/85	3						
	10/30/87	< 5 ^a						
Site 9	10/15/84	8	8	3	3.0	4.33	4.30	13.75
	10/23/90	< 1 ^a						
	6/25/90	< 1 ^a						
SPERT 1	10/12/84	6	6	3	3.2	2.57	4.30	9.54
	8/6/85	1						
	10/24/87	< 5 ^a						
SPERT 2	10/12/84	4	4	2	3.3	1.06	12.71	12.78
	10/24/87	< 5 ^a						
USGS 5	10/30/84	4	4	2	2.5	2.12	12.71	21.57
	9/26/90	1						
USGS 20	5/30/91	< 10 ^a	5	1	< 10 ^a	NA ^b	NA	NA
USGS 82	10/3/84	2	2.5	2	2.3	0.35	12.71	5.43
	10/6/87	< 5 ^a						
USGS 107	10/3/84	< 2 ^a	3	3	2.2	1.04	4.30	4.75
	8/16/85	3						
	10/9/87	< 5 ^a						

a. A value equal to one-half of the method detection limit (MDL) was used to calculate maximum, average, and standard deviation for a sample concentration of less than the MDL. (The value indicated is the MDL for those results with a < qualifier.)

b. NA means data are not available.

Table 4-6. Total unfiltered lead concentrations in groundwater at WAG 5 with calculated 95% upper confidence level estimates of mean concentrations.

Well	Date	Sample Data			Calculation of 95% Upper Confidence Level Assuming a Normal Distribution				
		Concentration (µg/L)	QA/QC Flags	Maximum (µg/L)	Sample Count	Arithmetic Mean (µg/L)	Standard Deviation (µg/L)	T Statistic (µg/L)	95% UCL (µg/L)
ARA-MON-AQ-001	April 95	15.4/11.8 ^a		15.4	5	11.8	2.91	2.78	15.38
	July 95	8.7/9.1 ^a							
	August 97	13.8							
ARA-MON-AQ-002	April 95	14.4	NJ ^b	14.4	3	13.5	0.76	4.3	15.41
	July 95	13.2	J ^c						
	August 97	13.0							
ARA-MON-AQ-003A	April 95	11.6		22.2	3	15.6	5.74	4.3	29.87
	July 95	13.1							
	August 97	22.2							
ARA-MON-AQ-004	April 95	14.0		49.2	3	26.7	19.56	4.3	75.24
	July 95	16.8							
	August 97	49.2							
PBF-MON-AQ-001	April 95	10.2/20.8 ^a	J	20.8	5	9.1	7.46	2.78	18.42
	July 95	3.5/1.8 ^a	J						
	August 97	9.4							
PBF-MON-AQ-003	April 95	4.2	J	4.2	3	2.4	1.64	4.3	6.46
	July 95	1.0	U ^d						
	August 97	2.0	U ^d						
PBF-MON-AQ-004	August 97	11.2/11.2 ^a		11.2	2	NA	NA	NA	NA
PBF-MON-AQ-005	August 97	12.7		12.7	1	NA	NA	NA	NA
SPERT 1	August 97	30.0		30.0	1	NA	NA	NA	NA

a. Duplicate samples were collected during April 1995 and July 1995 and are listed as sample / duplicate.

b. NJ indicates presumptive evidence of the presence of the analyte at an estimated quantity.

c. J indicates that the analyte was positively identified, but the associated numerical value may not be an accurate representation of the amount actually present.

d. U indicates that the material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.

4.3.4.3 Potential Sources for Lead in Groundwater. While the limited data presented above do not provide clear evidence of elevated lead concentrations in groundwater beneath WAG 5, the possibility that anthropogenic lead concentrations exist cannot be ruled out. Because of this, possible sources of lead contamination have been reviewed to ensure that activities at WAG 5 are not causing groundwater contamination. The four possible sources or causes for elevated lead concentrations in groundwater samples from WAG 5 are as follows:

- Naturally occurring lead concentrations
- Transport of lead from WAG 5 soil contamination to the aquifer
- Contamination from well construction
- Sampling or laboratory analytical problems.

The potential for locally concentrated lead in the basalts and sediments that compose the subsurface at the INEEL is negligible. As a geologically mobile trace metal, lead tends to be concentrated in hydrothermal alteration features within a host rock. Such features are not present in the basalts that form the active portion of the aquifer beneath the INEEL. In addition, if the abundant lead were transported as a component of the interbed sediments within the Snake River Plain basalts, the occurrence of high lead values would be much more diffuse than the very localized area occupied by WAG 5. Therefore, naturally occurring elevated lead concentrations, while possible, are not a likely cause of elevated lead concentrations in the environment at the INEEL.

With the exception of the SL-1 Burial Ground (ARA-06), the potential for lead contamination in groundwater from known soil contamination sites at WAG 5 has been evaluated through GWSCREEN transport modeling. The results of this modeling are contained in Section 5. Five sites with lead-contaminated soils were evaluated: ARA-01, ARA-02, ARA-12, PBF-16, and PBF-22. In all cases, the very conservative estimates of lead concentrations in groundwater from soil contamination were less than or equal to 1 µg/L. Furthermore, the transport time required to reach the peak concentrations was greater than or equal to 19,000 years for all five sites. The results of the GWSCREEN modeling indicate that the lead contamination in soils at WAG 5 cannot be the cause of elevated lead concentrations in groundwater. Though lead sheeting was buried in the SL-1 burial ground, modeling of nonradiological constituents was not performed. However, based on location and groundwater flow direction, potential transport of lead from ARA-06 cannot explain elevated lead concentration in the PBF area or in Well ARA-003A. Given the extremely low transport rate of lead predicted with the GWSCREEN modeling for other WAG 5 sites, the potential for waste lead in the SL-1 burial ground to cause elevated lead concentrations in the groundwater at WAG 5 is assumed to be negligible.

Well construction information was reviewed to determine whether a cause for elevated lead concentrations could be found (Neher 1998). Drill rig histories did not indicate potential equipment contamination with lead. All well construction materials were reviewed. Clean material appropriate for the construction of an environmental monitoring well was used. Well casings, screens, and sampling pumps were all constructed of stainless steel. Based on this review, the well construction material is an unlikely source of the potentially elevated lead concentrations observed in WAG 5 groundwater samples.

The remaining, and most likely, cause of the apparently elevated lead concentrations is sampling error. Evidence of the possible error was observed in the April 1995 duplicate samples from Well ARA-001, for which the sample values were 8.2 µg/L and 75.7 µg/L. The potential exists for particulate matter from the well to be included in the water sample. The occasional incorporation of particles into the groundwater samples may explain the few relatively high lead results that occur amid a

larger number of typically lower values. With a larger data set, the apparent outlier values could be discriminated from the bulk of the data.

4.3.4.4 Summary of Lead in Groundwater. In summary, elevated lead concentrations could occur in groundwater at WAG 5 that exceed the action level of 15 µg/L. Sporadic high values provide evidence to support this conclusion, though no clear trend can be determined because of the relatively small data set available for analysis. By evaluating the combined RI/FS dissolved lead data set, it was not possible to determine a statistically significant increase in lead concentrations in WAG 5 monitoring wells over those in the combined USGS data set. This does not, however, rule out the possibility of elevated lead concentrations in an individual well. Additional groundwater sample collection will occur annually for the next 5 years as part of the SL-1 Burial Ground monitoring. The additional data, as they become available, should be used to further evaluate lead in groundwater at WAG 5.

Regardless of whether lead concentrations are elevated, it does not appear that lead contamination in soils at WAG 5 could be a source of lead contamination in groundwater beneath WAG 5. GWSCREEN modeling of lead-contaminated soils, discussed further in Section 5, indicates that the maximum groundwater concentration from known WAG 5 lead sources is approximately 1 µg/L. This peak concentration is estimated to occur at greater than 19,000 years in the future. If continued groundwater monitoring yields a clear indication that lead concentrations are elevated, lead sources at WAG 5 could be further evaluated by using inverse modeling with GWSCREEN to estimate a hypothetical source term in soil necessary to generate groundwater concentrations of 15 µg/L. This simple inverse modeling would provide a valuable yardstick against which the known lead sources could be measured.

4.4 References

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